Report No. NAWCADWAR-93089-60

AD-A278 769

A DATABASE TO EVALUATE ACCELERATION (+Gz) INDUCED LOSS OF CONSCIOUSNESS (G-LOC) IN THE HUMAN CENTRIFUGE

Estrella M. Forster, M.S.
Air Vehicle and Crew Systems Technology Department (Code 6023)
NAVAL AIR WARFARE CENTER
AIRCRAFT DIVISION WARMINSTER
Warminster, PA 18974-0591

20 JUNE 1993

FINAL REPORT
Period Covering June 1992 to June 1993

Approved for public release; Distribution is Unlimited.

Prepared for
Air Vehicle and Crew Systems Technology Department (Code 602C)
NAVAL AIR WARFARE CENTER
AIRCRAFT DIVISION
Warminster, PA 18974-5000

NOTICES

REPORT NUMBERING SYSTEM — The numbering of technical project reports issued by the Naval Air Warfare Center, Aircraft Division, Warminster is arranged for specific identification purposes. Each number consists of the Center acronym, the calendar year in which the number was assigned, the sequence number of the report within the specific calendar year, and the official 2-digit correspondence code of the Functional Department responsible for the report. For example: Report No. NAWCADWAR-92001-60 indicates the first Center report for the year 1992 and prepared by the Air Vehicle and Crew Systems Technology Department. The numerical codes are as follows:

CODE	OFFICE OR DEPARTMENT
00	Commanding Officer, NAWCADWAR
01	Technical Director, NAWCADWAR
05	Computer Department
10	AntiSubmarine Warfare Systems Department
20	Tactical Air Systems Department
30	Warfare Systems Analysis Department
50	Mission Avionics Technology Department
60	Air Vehicle & Crew Systems Technology Department
70	Systems & Software Technology Department
80	Engineering Support Group
90	Test & Evaluation Group

PRODUCT ENDORSEMENT — The discussion or instructions concerning commercial products herein do not constitute an endorsement by the Government nor do they convey or imply the license or right to use such products.

Reviewed By: Philip E. Whitley Date: 17 Dec 93
Branch Head

Reviewed By: T M Mitchell Date: 12/20/93
Division Head

Reviewed By: Donald P. McErlean Date: 12/21/93
Director/Deputy Director

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
20 June 1993

3. REPORT TYPE AND DATES COVERED
Final 6/92–6/93

4. TITLE AND SUBTITLE
A DATABASE TO EVALUATE ACCELERATION (+Gz) INDUCED LOSS OF CONSCIOUSNESS (G-LOC) IN THE HUMAN CENTRIFUGE

5. FUNDING NUMBERS

6. AUTHOR(S)
Estrella M. Forster, M.S.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Vehicle and Crew Systems Technology Department (Code 6023)
NAVAL AIR WARFARE CENTER: AIRCRAFT DIVISION WARMINSTER
Warminster, PA 18974-0591

8. PERFORMING ORGANIZATION REPORT NUMBER
NAWCADWAR-93089-60

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Vehicle and Crew Systems Technology Department (Code 6023)
NAVAL AIR WARFARE CENTER: AIRCRAFT DIVISION WARMINSTER
Warminster, PA 18974-0591

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

BACKGROUND. Pilots of high performance aircraft may be exposed to positive acceleration (+Gz). This type of acceleration displaces blood in the head to foot direction. As the pressure in the vessels of the lower body increases, the vessels dilate, and a major proportion of the blood from the upper part of the body is shifted into these lower vessels. The pooling of blood in the lower extremities translates into a reduced cardiac output provoking the cardiovascular system to maintain adequate blood flow to the central nervous system and thereby maintain normal brain function. The symptoms of acceleration stress may lead to +Gz induced loss of consciousness (G-LOC) with potential fatal consequences. According to a survey done in 1986, approximately 12% of the Navy aircrew have experienced G-LOC inflight. **INTRODUCTION.** When G-LOC descriptive data is available, it is usually limited to the particular investigator's research interests. Most research regarding G-LOC does not include the symptoms typical of this event. Specifically, the subject's psychological reaction to the G-LOC episode itself is often ignored. Understanding the physiology and mechanism of G-LOC is necessary to develop methods to avoid such an event. However, until an infallible method to *prevent* G-LOC is developed, G-LOC will occur. Hence, the thrust of G-LOC research should include understanding recovery from unconsciousness; to include G-LOC's psychological sequelae.

14. SUBJECT TERMS
Positive Acceleration, Induced Loss of Consciousness (G-LOC)

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

G-LOC recovery being the integration of physiologic and psychological factors. **METHOD.** To this end. a questionnaire and a data repository were developed to compile all information available when G-LOC occurs in the centrifuge laboratory. The repository is composed of eighty-three variables encompassing four areas of study: 1) subject description; 2) acceleration profile/study characteristics: 3) G-LOC description; and 4) psychological sequelae of G-LOC. The latter mostly addressed by a questionnaire which encompass 17 multiple choice and assay items. The data repository was chosen to be formulated in accordance to Dbase III Plus® (Ashton-Tate) format because of its ease of handling. The characteristics and applications of the database and the questionnaire are discussed in the text. **RESULTS.** 279 G-LOC episodes were considered. Incapacitation time resulting from gradual onset rate exposures was longer than that resulting from rapid onset rate exposures. Eighty-seven percent of the subjects exhibited flailing behavior whereas only 68% recalled having flailed. Sixty-eight percent of the subjects exhibited respiratory symptoms (snorting, moaning, etc.). Visual imageries (i.e., dreams) were reported of 43% of the G-LOC episodes. Visual imagery was associated with longer absolute and total incapacitation periods. Thirty-nine percent of the subjects did not recall having experienced black-out prior to unconsciousness. Transient paralysis upon regaining consciousness was reported of 12% of the G-LOC episodes. A shorter total incapacitation was associated with prior G-LOC recovery. Defining these symptoms is paramount in G-LOC research. Establishment of a standard G-LOC database and questionnaire in the various centrifuge laboratories will 1) provide for large sample data analysis: 2) allow the integration of both physiologic and psychological measurements: and 3) provide an opportunity to develop comparison studies among research laboratories.

ACKNOWLEDGMENTS

I would like to express my sincere appreciation to the many people who supported this retrospective study. Without their willing assistance, this paper would not have been successfully completed. I thank, Leon Hrebrien, PhD, Stanley Zeitz, PhD, Phil Whitley, PhD, Stephen Dubin, PhD, and Tom Moore, PhD, for their valuable editorial comments and support.

To the faculty and staff of Drexel University; the Biomedical Engineering Institute and the Quantitative Methods Department in the College of Business, thank you.

I would like to recognize the staff of Code 6025 at the Naval Air Warfare Center, Aircraft Division, Warminster and the subjects who were trained at this facility. This paper would have been impossible without their cooperation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

Appendix Figure — *Page*

ABSTRACT

BACKGROUND. Pilots of high performance aircraft may be exposed to positive acceleration (+Gz). This type of acceleration displaces blood in the head to foot direction. As the pressure in the vessels of the lower body increases, the vessels dilate, and a major proportion of the blood from the upper part of the body is shifted into these lower vessels. The pooling of blood in the lower extremities translates into a reduced cardiac output provoking the cardiovascular system to maintain adequate blood flow to the central nervous system and thereby maintain normal brain function. The symptoms of acceleration stress may lead to +Gz induced loss of consciousness (G-LOC) with potential fatal consequences. According to a survey done in 1986, approximately 12% of the Navy aircrew have experienced G-LOC inflight. **INTRODUCTION.** When G-LOC descriptive data is available it is usually limited to the particular investigator's research interests. Most research regarding G-LOC does not include the symptoms typical of this event. Specifically, the subject's psychological reaction to the G-LOC episode itself is often ignored. Understanding the physiology and mechanism of G-LOC is necessary to develop methods to avoid such an event. However, until an infallible method to prevent G-LOC is developed, G-LOC will occur. Hence, the thrust of G-LOC research should include understanding recovery from unconsciousness; to include G-LOC's psychological sequelae. G-LOC recovery being the integration of physiologic and psychological factors.

METHOD. To this end, a questionnaire and a data repository were developed to compile all information available when G-LOC occurs in the centrifuge laboratory. The repository is composed of eighty-three variables encompassing four areas of study: 1) subject description; 2) acceleration profile/study characteristics; 3) G-LOC description; and 4) psychological sequelae of G-LOC. The latter mostly addressed by a questionnaire which encompass 17 multiple choice and assay items. The data repository was chosen to be

formulated in accordance to Dbase III Plus© (Ashton-Tate) format because of its ease of handling. The characteristics and applications of the database and the questionnaire are discussed in the text. **RESULTS.** 279 G-LOC episodes were considered. Incapacitation time resulting from gradual onset rate exposures was longer than that resulting from rapid onset rate exposures. Eighty-seven percent of the subjects exhibited flailing behavior whereas only 68% recalled having flailed. Sixty-eight percent of the subjects exhibited respiratory symptoms (snorting, moaning, etc.). Visual imageries (i.e., dreams) were reported of 43% of the G-LOC episodes. Visual imagery was associated with longer absolute and total incapacitation periods. Thirty-nine percent of the subjects did not recall having experienced black-out prior to unconsciousness. Transient paralysis upon regaining consciousness was reported of 12% of the G-LOC episodes. A shorter total incapacitation was associated with prior G-LOC experience. **CONCLUSION.** Psychological sequelae of G-LOC are an integral part of G-LOC recovery. Defining these symptoms is paramount in G-LOC research. Establishment of a standard G-LOC database and questionnaire in the various centrifuge laboratories will 1) provide for large sample data analysis; 2) allow the integration of both physiologic and psychological measurements; and 3) provide an opportunity to develop comparison studies among research laboratories.

BACKGROUND

Velocity, a vector quantity, describes the rate of movement of an object and the direction in which it moves:

$$Velocity = Distance / Time$$

The mean linear acceleration (a) of an object, a vector quantity, describes the rate of change in velocity (v):

$$a = [v2 - v1] / \Delta t$$

Velocity and acceleration imply motion. The relationship of motion and the force required for this motion is described by Newton's Laws which briefly state: 1) an object will remain at rest unless acted upon by a force. Hence, accelerations result from the action of forces; 2) accelerations result in changes of weight. That is, F = ma (force equals mass times acceleration). The unit of this force is the newton which is the weight of 1 Kg mass under standard conditions of gravity. The standard gravitational acceleration is defined by g and is equivalent to 32.2 ft/s^2. Hence, W = mg (weight equals mass times gravitational acceleration).

"When a man is sitting in his [aircraft] seat, the force with which he is pressing against the seat results from the pull of gravity" This force is equal to his weight. The intensity of this force is +1 Gz (equal to the pull of gravity). "If the force with which he presses against the seat becomes five times his normal weight (as in pulling out from a dive, while flying), the force acting upon the seat is 5 +Gz" (26). For example, the +Gz force experienced by a pilot flying at 630 knots in a turn of 3500 ft is:

$$a = v^2 / r = \{[630 \text{ knots/hr}] * [6080 \text{ ft/knot}] * [1 \text{ hr} / 3600 \text{ s}]\}^2 \; / \; 3500 \text{ ft} = 323.45 \text{ ft/s}^2$$

$$+Gz = a / g_0 = 323.45 / 32.2 = 10.04 \; +Gz$$

Pilots of high performance aircraft may be exposed to positive acceleration (+Gz). This type of acceleration displaces blood in the head to foot direction. As the pressure in the vessels of the lower body increases, the vessels passively dilate, and a major portion of the blood from the upper part of the body is translocated into these lower vessels (26). The pooling of blood in the lower extremities translates into a reduced cardiac output provoking the cardiovascular system (mainly the activation of baroreceptor reflexes) to attempt to maintain adequate blood flow to the central nervous system (CNS) and thereby maintain normal brain function.

The effects of +Gz on human physiology are mainly cardiovascular in nature. These have been described based on a hydrostatic column model where the model is assumed to be non distensible and without reflexes. Figure 1 describes this model which allows the estimation of the vascular pressures that develop during +Gz stress.

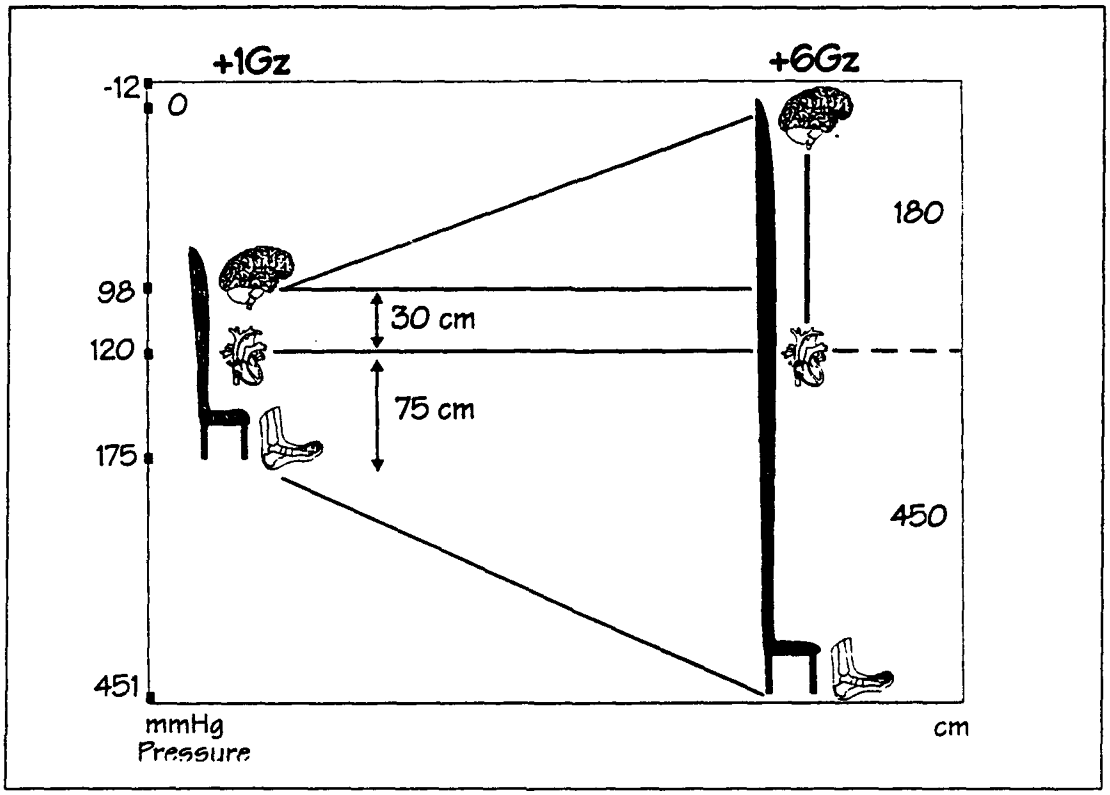


Figure 1. Hydrostatic column representation of +Gz force.
adapted from Leverett SD et al (37)

The figure assumes a heart to eye-brain distance of 30 cm. This distance would exert a hydrostatic column pressure of 120 mmHg at heart level where 22 mmHg is due to a hydrostatic column effect. This results in a predicted blood pressure at eye level of 98 mmHg at +1 Gz. For each additional +Gz, the blood pressure at eye level will be reduced by the same amount so that at +5.5 Gz blood pressure at eye level would be zero (37).

Acceleration stress effects on human physiology have been studied in the human centrifuge since the 1930's. The first protective measure against +Gz forces is a series of reflex cardiovascular changes. Upon acceleration, there is an immediate hydrostatic pressure drop from aorta to carotid sinus generating a simultaneous stimulation of the vasomotor center. This action results in vasoconstriction, increased blood pressure, increased cardiac contractility and a rise in heart rate. Simultaneously, the vasomotor center and other areas

of the reticular formation of the brain transmit impulses to the abdominal muscles resulting in higher muscle tone and contraction of abdominal viscera. These events compress the abdominal venous reservoirs to translocate blood out of the abdomen toward the central circulation (26). This response is enhanced by anxiety, straining maneuvers performed by the subject, and the anti-G suit (discussed below). Reflex tachycardia occurs in an effort to normalize the blood supply to the brain and other tissues. Figure 2 describes the of +Gz on heart rate (HR) during a very high onset rate +Gz (VHOG) exposure of o + Gz/s.

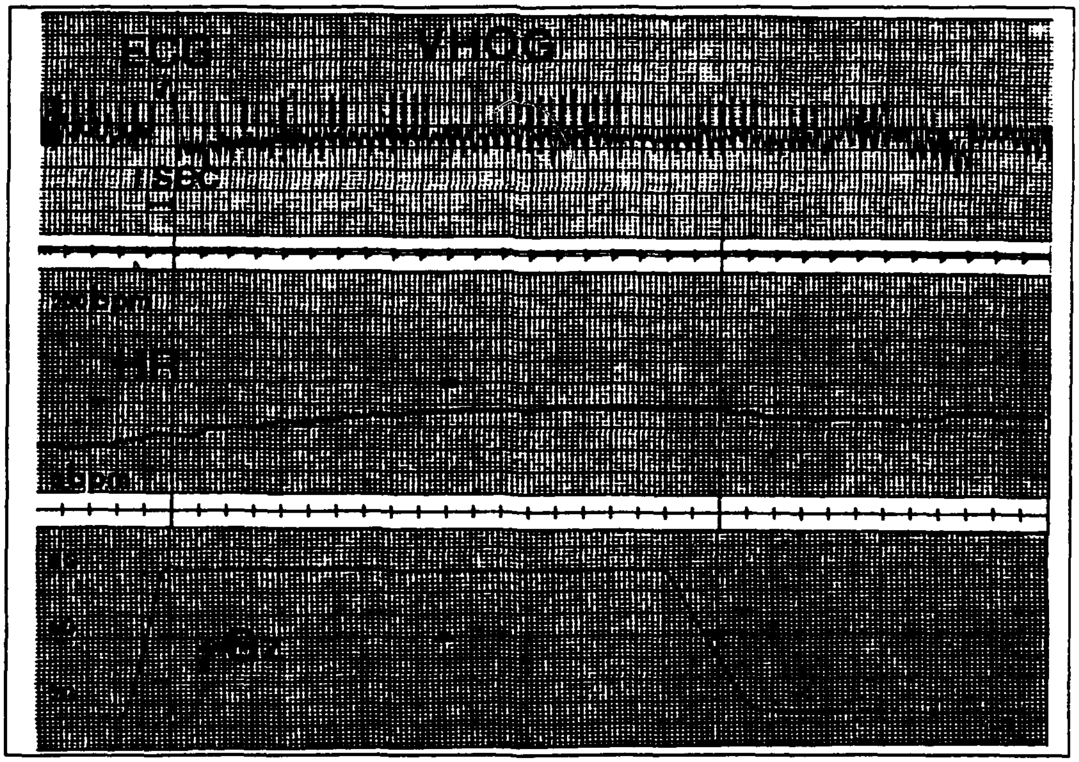


Figure 2. Heart rate response to rapid onset +Gz exposures

From Forster EM et al (23)

Figure 3 describes the heart rate (HR) response to a gradual onset rate exposure (GOR) of 0.1 +Gz/s. In brief, heart rate does not predict +Gz tolerance. There is a greater change in

heart rate per +Gz level as acceleration increases during gradual onset runs than rapid onset runs where the change in heart rate per +Gz level is reduced by 50% as the onset rate is increased from 0.1 +Gz/s to 1 +Gz/s and 6 +Gz/s (16-18,23,41,50).

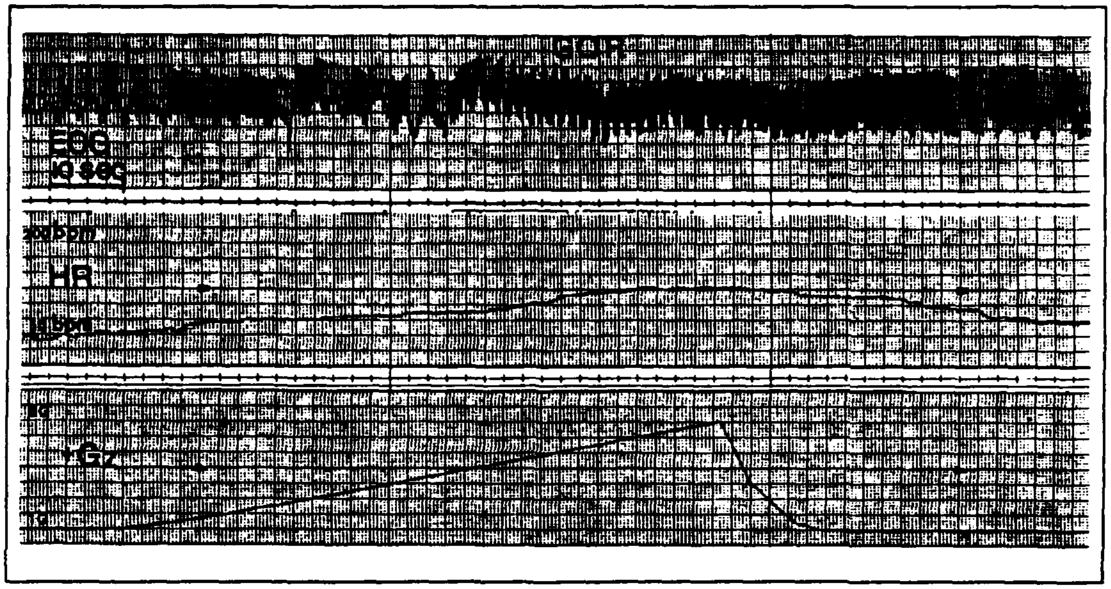


Figure 3. Heart rate response to gradual onset +Gz exposures
From Forster EM et al (23)

The most obvious symptom of +Gz stress is commonly known as petechia hemorrhages ("high-G measles") which are burst capillaries usually present in the limbs due to the displacement of blood towards the extremities. Pulmonary function is also affected by +Gz stress where ventilation and perfusion are further affected by protective measures. Hence, respiratory rate, tidal volume, arterial oxygen tension, and the physiologic dead-space increase as +Gz increases. Carbon dioxide tension and pH do not change considerably. The electrical activity of the brain as measured by the electroencephalogram (EEG) is also influenced by +Gz where absolute central nervous system blood flow produces

large magnitude EEG changes; vestibular stimuli produce transitory changes in EEG intensity; and metabolic processes in the CNS and compensatory hemodynamic mechanisms yield long duration shift in baseline intensity (37). Hence, the physical symptoms of acceleration stress range from the development of petechia hemorrhages to loss of vision and eventually +Gz induced loss of consciousness (G-LOC) — with potential fatal consequences.

In the past, research on the effects of positive acceleration (+Gz) in man was focused on the physiology of the cardiovascular system. During that time, acceleration induced loss of consciousness was acknowledged, yet, its significance was overlooked. Recently, the understanding of the neurophysiology of G-LOC has become paramount in aeromedical research not only because of the danger G-LOC imposes on fighter aviation but because of the wealth of information a G-LOC episode imparts. Indeed, loss of consciousness and the psychological phenomena associated with unconsciousness are not only a fighter aviation medicine problem but also represent research avenues that complement other scientific and therapeutic endeavors in clinical medicine.

G-LOC is currently considered a random event. To date, no physiologic variable has been definitely linked with a "predisposition to G-LOC" Indeed, this is the goal of current G-LOC research; to be able to predict G-LOC and therefore either avoid it or develop an aircraft recovery mechanism in the event of G-LOC inflight: in a 1986 survey, 12% of Navy pilots reported G-LOC inflight (34); the Air Force has reported 18 accidents (14 fatalities) due to G-LOC (1982 to 1990 period, 39). Hence, the current main concern in aeromedical research is the maintenance of consciousness in the +Gz environment. In this regard, two anatomical areas are of interest: the brain and the eye. Under high +Gz stress, the eye "notifies" the brain that G-LOC may occur by losing vision to the point of blackout (complete loss of vision). Loss of vision usually is a precursor to G-LOC.

Henry et al (28) found that consciousness was lost when mean cerebral blood pressure fell below 25 mmHg and that a mechanism that compensates for the fall in cerebral arterial pressure induced by +Gz was evident. He further stated that significant deep channels which can remain patent in spite of subatmospheric pressures are available for the return of blood to the brain. Howard (31) explained the development of markedly sub-atmospheric pressures in the jugular veins at high +Gz levels ensures that the fall in arterial pressure is counter-balanced by the formation of a siphon so that "blood is sucked through the brain...adequate perfusion is accordingly preserved at levels of acceleration greater than would be predicted by hydrostatic theory alone, and consciousness is maintained until collapse of the jugular veins breaks the siphon." Krutz et al (36) found that the onset of zero forward blood flow in the temporal artery coincided with a reduction in mean arterial pressure to 20 mmHg and that this reduction occurred 4-9 s prior to blackout. Wood et al (65) found that the average latent period after the onset exposures to accelerations greater than +3Gz was 6.8 s (3.5-9 s) suggesting that G-LOC is caused by a sudden acute stoppage or near stoppage of cerebral blood flow. Glaister (23) found that there is less blood in the brain during +Gz and this reduction is proportional to the reduction in HbO_2. Further, the disappearance of the blood and the eventual level achieved is proportional to the +Gz level achieved. Burton (9) has noted that G-LOC is not a problem related to blood oxygen content per se but rather a problem of getting blood to the appropriate places in the body. Sandler et al (46) found that a minimum of 6 seconds of total brain blood flow cessation was necessary before black-out occurred. The cessation of flow correlated consistently with loss of peripheral vision. Werchan (52), using Doppler methodology, obtained middle cerebral artery blood flow velocity in one subject who experienced G-LOC during a +5 Gz exposure. Systolic blood flow was not detectable within 4 s after the subject attained this +Gz level. Figure 4 shows the peak blood flow velocities of the middle cerebral artery where 1 Khertz / s Doppler frequency shift (the ordinate in the graph) is approximately 39 cm/s blood flow velocity.

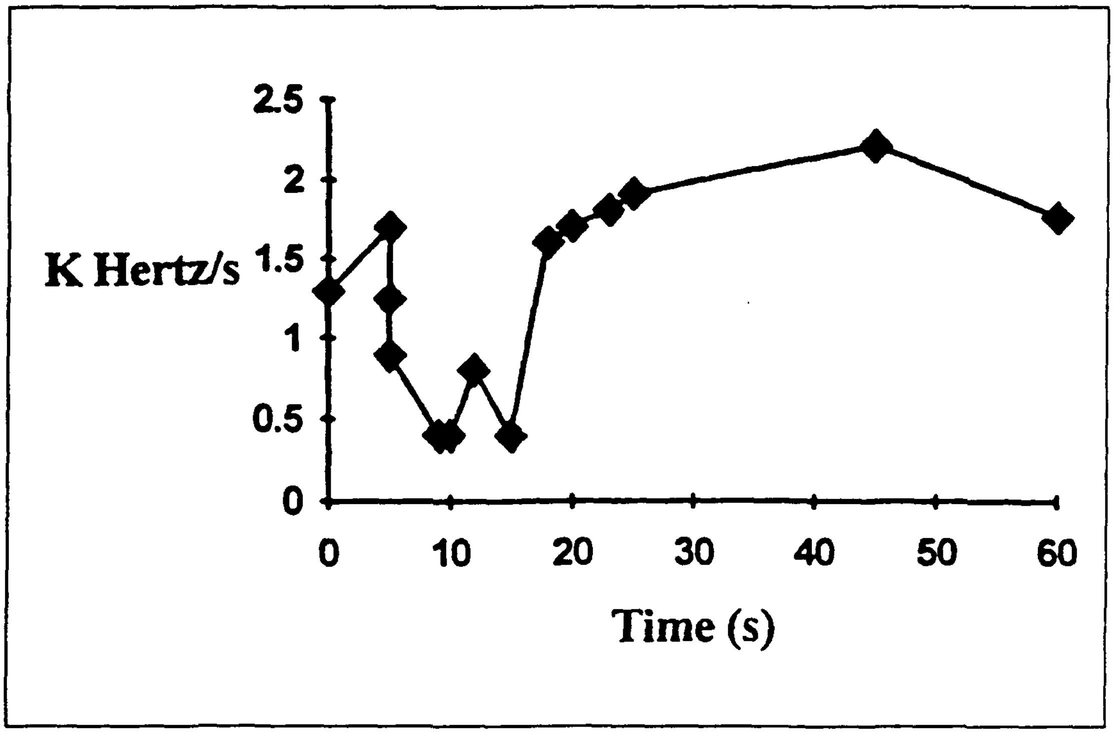


Figure 4. Middle cerebral artery blood flow velocity leading to G-LOC
adapted from Werchan PM (52) G-LOC at approximately 11 s marker

The question of blood availability to the brain has been addressed in terms of the mechanism of G-LOC (57). This mechanism is based on the observation of symptoms resulting from G-LOC and the time sequence of these symptoms. In essence, when blood flow to the CNS is reduced by +Gz stress, ischemia/anoxia occurs in a "top to bottom, watershed pattern based on the CNS circulatory system. To ensure maximum survival, the neurons optimize energy conservation by minimizing extracellular activity. This local inhibition reduces electrical output to other neurons and neuronal metabolic expenditure. When a critical mass of locally inhibited neurons is attained, the inhibitory reticular formation becomes disinhibited and gains control of the CNS through induction of global inhibition. The onset of this global inhibition is loss of consciousness, an active mechanism to protect

the integrity of the CNS. The process above is termed the functional buffer period or loss of consciousness induction time. As blood flow returns, the neuronal inhibition is reduced and segments of the CNS become sequentially re-activated. The CNS regains function beginning with the primitive system, and progressing toward the cortical system. The proposed mechanism is basically a concerted effort to protect the CNS from injury" (Figure 5, 56).

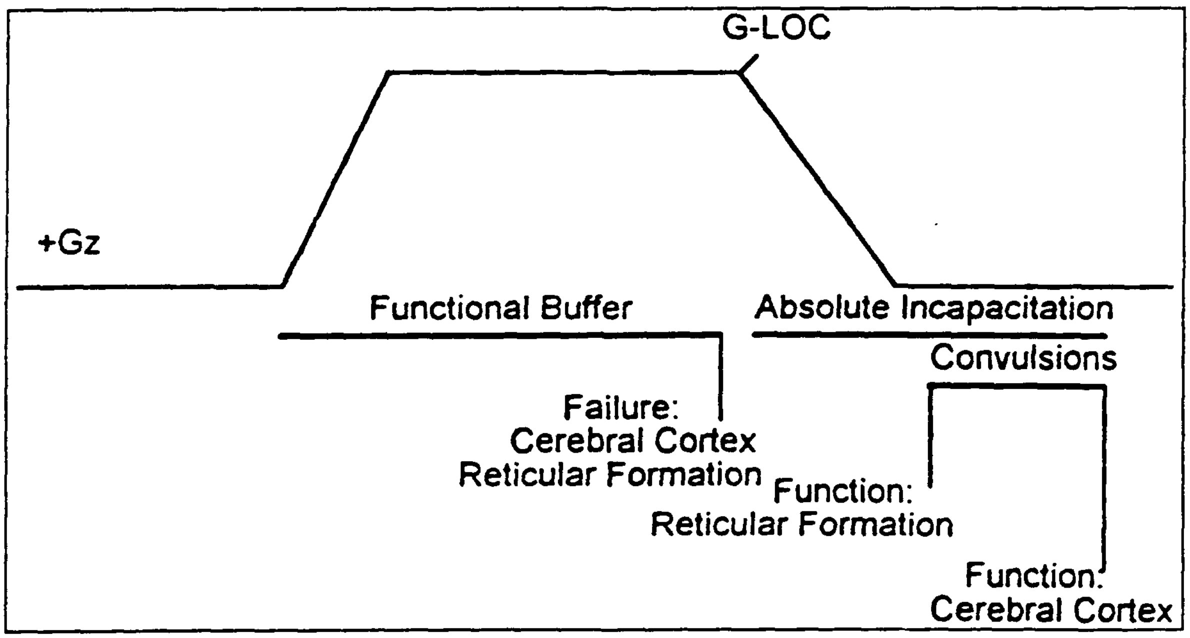


Figure 5. Schematic diagram of G-LOC
adapted from Whinnery JE (56)

Several methodologies have been utilized to study the physiology of G-LOC including 1) biochemical assays in animals (48-49,54) where findings include metabolic changes (in rats) to occur within 15s of +Gz stress, G-LOC occurring as a protective mechanism to slow metabolic rate preventing tissue lactate accumulation (acidosis). 2) modified accel-

eration protocols (4,11-13,55) such as aerial combat environment simulation (ACES); 3) timing of G-LOC symptoms (kinetics, 57,62) where the specific symptoms and periods of unconsciousness are timed so that their sequence may be associated to their physiologic correlates in the brain; 4) Doppler methodology (2,15,40,42,52-53) and near infrared monitoring (OMNI4, 25,27,33) have been utilized to determine brain blood flow and cerebral microcirculation where the rate of disappearance of the blood and the eventual level achieved is greater the higher the +Gz level. Also, cerebral blood flow velocity has been calculated to be reduced by up to 58% during certain +Gz profiles; 5) electrical activity of the brain (EEG) where delta waves are predominant during unconsciousness (1,5,22,38,44,51). Figure 6 describes 4 channels of EEG recordings of a subject who experienced G-LOC during ACES. Loss of consciousness occurred at +4.6 Gz where the maximum +Gz of the exposure was +7 Gz and the time of the exposure was 62 s; and 6) electrical activity of the heart (ECG) where no significant or predictive cardiovascular changes have been associated with G-LOC.

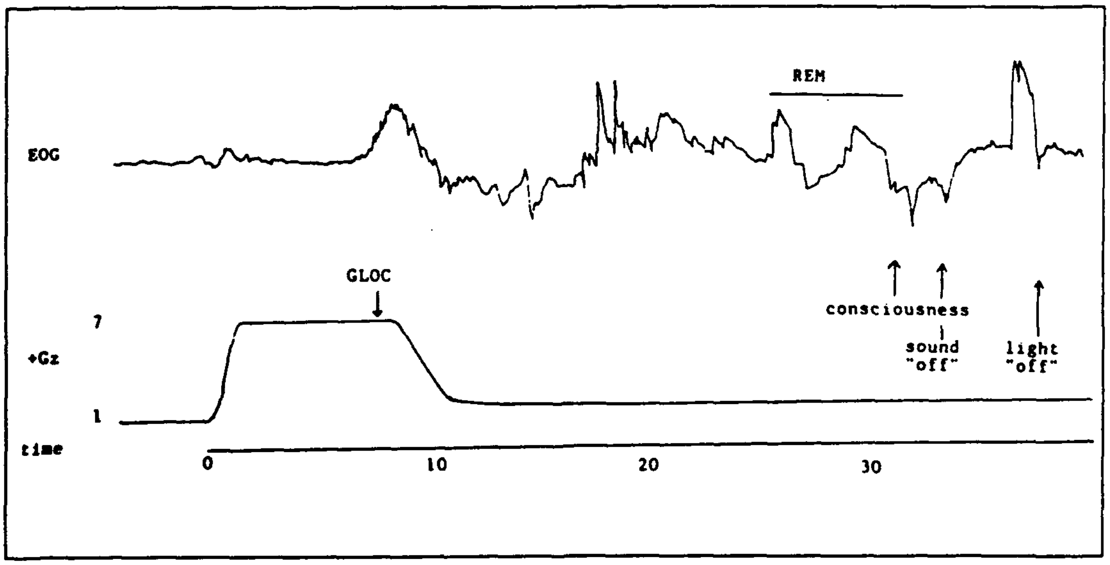


Figure 6. EEG during G-LOC

Protocols evaluating safety measures, techniques, or equipment to increase +Gz tolerance have been evaluated (4,6,19,55,59,63-66): 1) altering the offset rate of the +Gz exposure where a more rapid offset results in a shorter G-LOC incapacitation period; 2) altering the heart to eye distance (decreasing the hydrostatic column length) by modifying the subject position while experiencing +Gz stress where a supine position increases +Gz tolerance, reduces work effort (i.e., fatigue due to straining maneuvers) and mean heart rate associated with the +Gz stress. Figure 7 describes the head rest geometry of three different seat configurations, L, K, and M (NSRP= neutral seat reference point, 8);

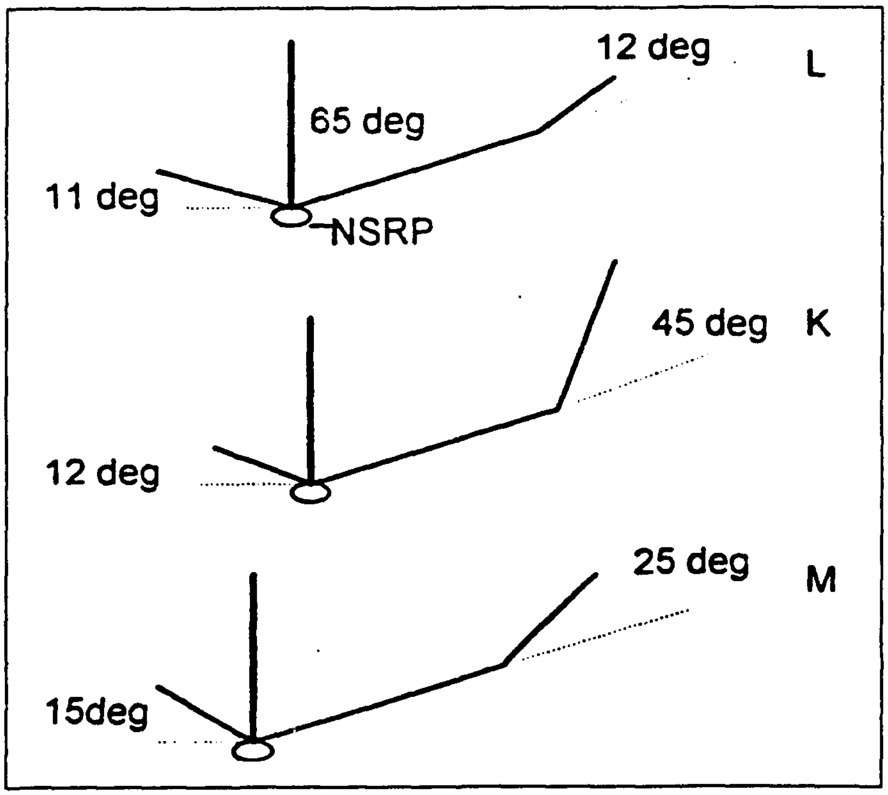


Figure 7 . Seat angle and head rest geometry
adapted from Burns JW et al (8)

3) implementing protective measures such as a) anti-g straining maneuvers (muscular straining while exhaling against a partially closed or fully closed glottis) which increase

+Gz tolerance by approximately 1.5 +Gz, b) anti-G suits and modification of their inflation profile where the suit is composed of air bladders which upon acceleration inflate against strategic areas of the anatomy in order to exert pressure upon the body and thereby ameliorate the effect of blood pooling towards the extremities during +Gz stress. It has been found that the suit provides added protection against this stress (Figure 8); and c) assisted positive pressure breathing (APPB) which increases +Gz tolerance through a secondary stimulation of the baroreceptor mechanisms. Burns et al (7), found that continuous APPB at 50 and 70 mmHg augments time at +Gz during simulated +5 to 9 +Gz simulated combat maneuver profiles (by 88% and 115% respectively, $p < .01$).

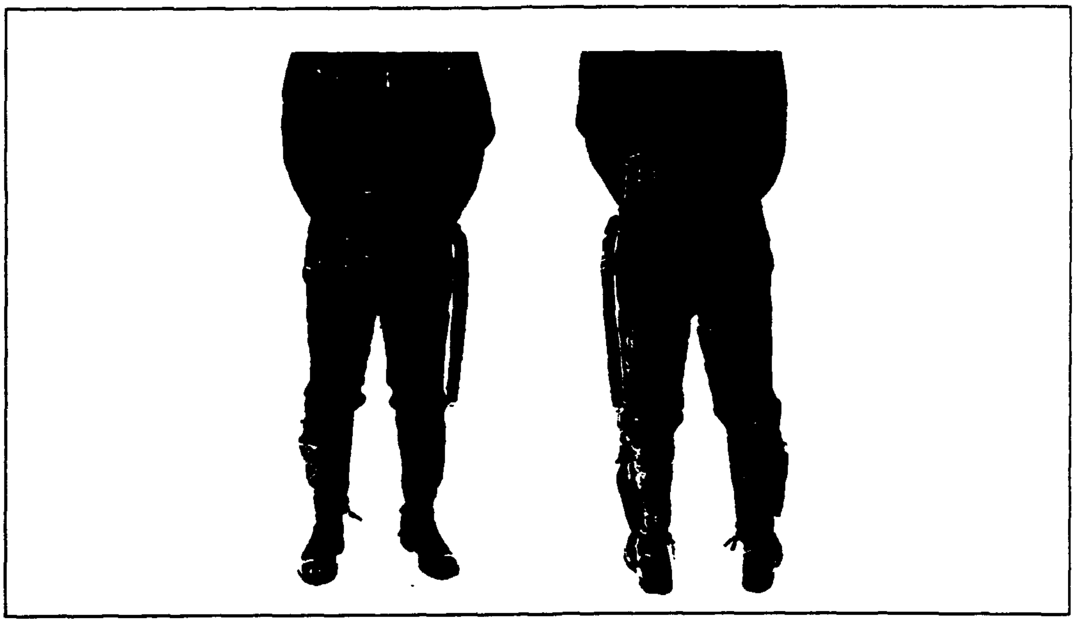


Figure 8. Anti-G suit
from Krutz RW et al (35)

4) aircrew of high performance aircraft are routinely trained in the acceleration environment to better tolerate this type of stress by use of the human centrifuge (Figure 9). This

training usually involves a lecture relating the physiologic effects of +Gz stress, the protective measures to better tolerate the stress and exposure to the stress itself (10,24,32,58).

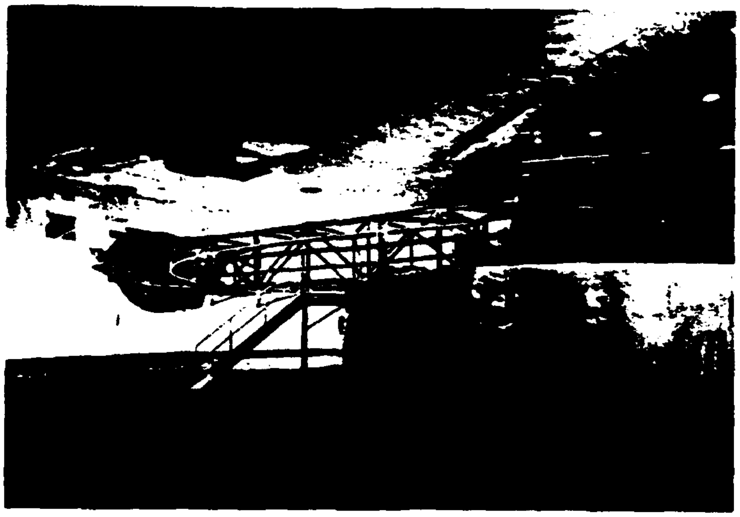


Figure 9. The human centrifuge at the Naval Air Warfare Center, Aircraft Division. Warminster, PA

In spite of the wealth of information physiologic measurements impart, an important aspect of +Gz stress and specifically G-LOC tends to be neglected: the recovery period and it's related symptoms. Human physiologic response to G-LOC is to be understood for a G-LOC predictive system/method to be developed. However, until an infallible system

of this nature is available, G-LOC will occur. Hence, the thrust of G-LOC research should include the understanding of its symptoms; specifically the psychological reaction to the G-LOC episode itself. Unfortunately, we tend to regard G-LOC as only a sequence of cardiovascular and/or neurologic changes. However, the G-LOC victim is also psychologically disturbed. The subjects experience confusion, euphoria, anxiety and frustration upon recovering from G-LOC (21-22,60). These disturbances affect recovery from G-LOC and the subsequent performance of flying maneuvers or related tasks; where complete recovery from G-LOC occurs approximately one minute post G-LOC (20,30). Incapacitation resulting from G-LOC is the combination of both physiologic and psychological factors. The latter have not been properly identified and are an integral part of recovery from G-LOC. Therefore, G-LOC research must be understood as the combined physiology and psychology of the subject experiencing this type of stress.

How do we study the "psychology of G-LOC"? By asking the subject: What happened? Why does he think it happened? Is he affected by the dream experienced during unconsciousness? Is his attitude about the episode affecting his recovery? Are the symptoms familiar to him? To this end, a questionnaire was developed to better evaluate the psychological effects of G-LOC. This questionnaire was formulated to be completed by subjects who experienced G-LOC in the human-use centrifuge.

This thesis addresses the formulation of a database and questionnaire and how these can be applied to aeromedical research addressing +Gz induced loss of consciousness.

INTRODUCTION

Why is a +Gz induced loss of consciousness data repository necessary?

1) Currently, data repositories for acceleration research data reside at Brooks AFB, TX (61) and the Naval Air Warfare Center, Aircraft Division in Warminster, PA (NAWC). These seem to be the only data repositories addressing +Gz related research. However, they do not include G-LOC descriptive variables. When G-LOC descriptive data is available, it is usually limited to the particular investigator's research interests. For example, the psychological sequelae of G-LOC are seldom if ever considered and it is undeniable that upon awakening from unconsciousness, the subject's state of mind may influence his/her reaction to the G-LOC episode and therefore his/her recovery and subsequent performance (20-22,30,60). A database which encompasses all information on a G-LOC episode has not been available until now.

2) Aircrew training on +Gz tolerance (in the human centrifuge) provides a rare opportunity to directly study the population of interest when G-LOC research is a concern and makes it imperative to collect data on those aircrew accidentally experiencing G-LOC during such training.

3) +Gz research usually involves small sample populations because of subject availability. Further, G-LOC itself is an unusual event. As such, all available information should be recorded whenever it occurs. A G-LOC database enables large sample data collection and therefore increases statistical analysis power.

4) A G-LOC data repository increases aviation safety by compiling isolated research results originating from any particular investigator addressing the G-LOC problem. The

establishment of G-LOC data repositories as the one presented herein provides an excellent means to develop comparison studies among the various +Gz research laboratories.

DESCRIPTION OF A METHOD TO DOCUMENT G-LOC

THE G-LOC DATABASE

The program Dbase III Plus® (Ashton-Tate) was chosen because of its simplicity and ease of handling. This characteristic is specially important since the data may be entered by any personnel familiar with computers and the program itself is well known and available to most researchers in the various acceleration +Gz research laboratories. Also, data can easily be retrieved and analyzed with any statistical package compatible with this format.

The database contains 83 variables which concern 4 areas of interest. These variables are described in detail in Appendix A:

- **I** Subject description in general (21 variables)
- **II** Acceleration profile and research study characteristics (15 variables)
- **III** G-LOC description (20 variables)
- **IV** Psychological sequelae of G-LOC (27 variables)

Data entry sheets were formulated (Appendix B) to facilitate data obtention and entry. Each variable is enumerated and the characters denoting missing and non-applicable entries are specified. The range of the variable is also noted when required. Once the data is collected, it is key punched via a microcomputer; in this case, the Gateway 2000®.

G-LOC DATABASE SOURCES

The data repository consists of data obtained from three sources:

Videotaped record of the G-LOC episode. These records are normally obtained during all centrifuge exposures at NAWC (Figure 10). The record contains: a video picture of the subject, a trace of the acceleration profile, a record of the base and peak +Gz level attained during each +Gz exposure, the subject's heart rate, and the time of the exposure (14).

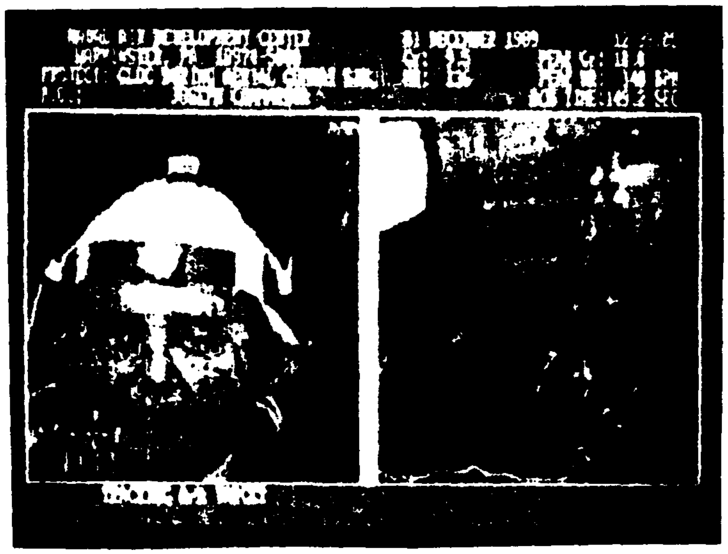


Figure 10. NAWC video tape documentation of +Gz exposures (14)

+Gz exposure data sheets. The +Gz exposure data sheet is a form completed by the subject and the centrifuge personnel. A sample developed by NAWC personnel is shown in Appendix B. The form records acceleration profile characteristics and subject characteristics as described in Appendix A.

G-LOC questionnaire. A partial sample of the questionnaire is shown in Figure 11. It was developed by this author in 1985. The questionnaire's aim was to obtain information on the subject's recollection of his state-of-mind as he awakened from unconsciousness and on how this state affected his performance, recovery, and interpretation of the G-LOC warning signals currently used in the centrifuge (a bright light and a loud horn). In essence, the questionnaire provided the subject and the investigator an opportunity to evaluate G-LOC beyond its physiologic symptoms. This evaluation was complemented by 1) the characteristics of the +Gz exposure and 2) the period of incapacitation resulting from G-LOC and its associated symptoms: 1. +Gz Profile Characteristics. The operational variables of a G-LOC episode refer to the +Gz profile and the study protocol itself such as +Gz onset rate, +Gz offset rate, maximum +Gz of the exposure; duration of the exposure, protective garments used, etc. Appendix A completely describes these variables. In brief, the training protocol discussed herein consisted of the following: a gradual onset rate exposure of 0.1 +Gz/s (GOR) followed by a series of rapid onset rate exposures of 6 +Gz/s (ROR) to various plateaus of +6Gz to +9Gz for periods of 10 to 15 s. There was a 1 to 5 minute lapse between the consecutive exposures. These were videotaped and, in the case of a G-LOC episode, the videotape was archived for later review. 2. G-LOC incapacitation. In general, incapacitation resulting from G-LOC has been classified into three parts: absolute incapacitation, the period when the subject is clearly unconscious (eyes roll backwards and close, head/body slump, convulsions); relative incapacitation, the period when the subject is awake but disoriented; and total incapacitation, the sum of absolute and relative incapacitations above and measured by the subject's deactivation (upon regaining consciousness) of the warning signals triggered by a medical monitor upon G-LOC.

The target population of the questionnaire included trainees participating in the +Gz tolerance program of the Navy (GTIP). These trainees included aircrew of the Navy and the Air National Guard. All subjects were over 21 years of age. Since G-LOC is an infrequent but significant event, the goal was to obtain a completed G-LOC questionnaire from all those trainees who experienced it. Non-response error was expected to be small.

The questionnaire (paper and pencil format) was presented to the subjects by trained Navy personnel (a "training coach") familiar with G-LOC and GTIP training. All questionnaires were completed at NAWC on the day of the G-LOC exposure after the subject exited the centrifuge. The questionnaires were collected at the end of the training day prior to the subjects leaving the premises.

Questionnaire completion immediately after G-LOC occurs is not always possible in the centrifuge laboratory. Hence, the physician or other personnel ask the subject an abbreviated version of these questions as the subject awakens from unconsciousness, while s/he is still in the centrifuge. The video record of the +Gz exposure aids the investigator in evaluating the subject's answers to the written questionnaire itself which is completed approximately less than 20 minutes after the +Gz exposure. As of this writing, a total of 292 questionnaires have been collected. A sample of the G-LOC questionnaire is shown in Appendix B.

The contents of the questionnaire were based on the critical incidence technique (3) to include an extensive review of G-LOC episodes recorded at the NAWC and Brooks AFB centrifuge laboratories (1984 to 1992). The questionnaire was ideally completed by the subject immediately after the G-LOC event in a quiet/private environment so that complete

recall of the G-LOC episode is not obstructed by peripheral stimuli. The subjects were informed of the nature of the questionnaire, and its completion was voluntary. The questionnaire construction was based on current designs recommended in the literature (3,45,47).

The questionnaire included 17 items: a) open ended (2 items); b) multiple choice (14 items where 5 items provided for a follow-up or clarification opportunity; and c) rating scale (1 item). The major areas addressed in the questionnaire were: 1) the subject's reaction to G-LOC (items 1-2, 4); 2) the subject's interpretation of the current human centrifuge G-LOC awakening stimuli (items 6-7); 3) the subject's dream-like episodes during G-LOC (items 12-16); and 4) G-LOC symptoms (convulsions, transient paralysis, items 3, 5, 7-11). Data management and organization was accomplished on Ashton Tate dbaseIIIP. Data analysis was achieved via Microsoft® Excel or SAS® statistical analysis package as required.

1. Describe how you felt as you were recovering consciousness by circling the appropriate number in each of the following (0 being lowest, 10 being highest):

Euphoria	0	1	2	3	4	5	6	7	8	9	10
Anger	0	1	2	3	4	5	6	7	8	9	10
Embarrassment	0	1	2	3	4	5	6	7	8	9	10
Apathy	0	1	2	3	4	5	6	7	8	9	10
Frustration	0	1	2	3	4	5	6	7	8	9	10
Confusion	0	1	2	3	4	5	6	7	8	9	10
Fright	0	1	2	3	4	5	6	7	8	9	10
Sadness	0	1	2	3	4	5	6	7	8	9	10
Surprise	0	1	2	3	4	5	6	7	8	9	10
Relaxation	0	1	2	3	4	5	6	7	8	9	10
Denial	0	1	2	3	4	5	6	7	8	9	10
Other:	rating (0-10)										

2. Were you surprised by your G-LOC or did you "feel it coming"?

SURPRISED   NOT SURPRISED

3. Did you experience black-out (100% light loss) prior to G-LOC?

YES   NO   DO NOT REMEMBER

4. Immediately after recovering consciousness (YOU HAVE JUST OPENED YOUR EYES), Did you know where you were [centrifuge] and why [i.e., training]?

YES   NO   Please explain (i.e., where were you?)

5. How long did your period of unconsciousness seem to last (estimate)?

SECONDS   MINUTES   HOURS   FOREVER

6. Were you aware of the warning signals DURING your period of unconsciousness? (i.e. were you able to hear the horn while you were unconscious?)

YES   NO   Please explain

e) I forgot what the signals meant.
f) I didn't know what the signals meant, was not told what the signals meant.
g) I didn't care about the signals, I had other thoughts on my mind at the time.
h) Other: ______________________________

Figure 11. G-LOC QUESTIONNAIRE

EVALUATION OF THE DATABASE

Appendix C comprises the complete results of a sample analysis of all the variables included in the G-LOC database. Each variable and its corresponding permutations is described separately in the following manner: The mean, standard deviation (± S.D.), number (N) of exposures (in parenthesis), bound of error (BOE), and range [in brackets]. For those variables defined by levels, the frequency of occurrence per level is shown. Percentage of occurrence is also shown with and without including missing data (defined by '.'). Total (T) number of occurrences are shown by each table. The variable units are noted in the boxed variable title. Further statistical analysis was performed when necessary. Only GTIP program subject-data was considered in this sample analysis. For further clarification, please refer to Appendix A where the variables are defined. A summary of the results follow:

☆ A total of 279 G-LOC exposures were considered.

☆ 73 % of the episodes were classified as classic G-LOC (BOE = 1%).

☆ The maximum +Gz level of the GOR exposures was 7 ± 1. This level was predetermined for the ROR exposures.

☆ The relaxed +Gz tolerance for the trainees was 4.6 ± 0.8

☆ During the ROR runs, 65 % of the G-LOC episodes occurred during plateau with a bound of error (BOE) of 0.6 %.

☆ The average duration time of this plateau was 5 ± 2 s.

☆ 70% of the G-LOC episodes occurred during ROR, 30% occurred during GOR (BOE= 6%). Note that 80% of all GTIP exposures are ROR runs.

☆ Absolute incapacitation was 7 ± 5 s. Relative incapacitation was 9 ± 4 s. Total incapacitation was 15 ± 6 s.

☆ Incapacitation resulting from GOR exposures was longer than that resulting from ROR exposures (p= .002).

☆ Convulsion induction time and absolute incapacitation were correlated (r= .6)

☆ 87% of the subjects exhibited convulsive behavior during G-LOC (BOE= 2%). However, only 68% remember having flailed. A longer absolute incapacitation was associated with major convulsive behavior (Duncan p= .05).

☆ 68% of the subjects exhibited major respiratory symptoms while unconscious (BOE= 3%). These symptoms were associated with longer absolute (p= .002) and total (p= .01) incapacitation periods.

☆ Audiovisual imageries were reported of 43% of the episodes (BOE= 3%). Of these, 75% were described as dreams comparable to those during normal sleep. Absolute and total incapacitations were longer of those episodes where dreams occurred (p= .002, and .000 respectively). In general, the imageries were familiar and pleasant in content.

☆ 39% of the subjects (BOE = 6%) did not remember having experienced blackout prior to G-LOC.

☆ 39% of the subjects did not know where they were [centrifuge] and why they were there [training] as they awakened from unconsciousness (BOE = 3%).

☆ When questioned on the interpretation of the warning signals and their reasons for not deactivating them upon recovering consciousness, 12% of the subjects reported temporary paralysis; as in not being able to move to deactivate the signals in spite of their wish to do so. (BOE= 5%). Other reasons were confusion (38 ± 7 %) and disinterest (11 ± 5 %).

☆ Total incapacitation was shorter (p= .02) with prior G-LOC experience. 5.6% was the percentage of prior G-LOC inflight experience.

☆ The subject's general state of mind as he awakened from unconsciousness as as follows (percent ± BOE): Confusion (69 ± 3); Surprise (52 ± 5); Relaxation (42 ± 4); Embarrassment (39 ± 3); Euphoria (38 ± 3); Apathy (36 ± 7); Frustration (36 ± 3); Amnesia (29 ± 6); Anger (22 ± 3); Denial (15 ± 3); Fright (13 ± 2); and Sadness (11 ± 2).

Following is an eloquent description of G-LOC and its psychologic implications as describes by a subject who experienced G-LOC in the centrifuge:

"It was a small form of death. Awakening from it was like being spit from the abyss, flung bodily back into consciousness, like being dumped into a vat of ice water from a warm deep sleep. Only this sleep was not warm, it was empty, nothingness, a bottomless abyss.

worse than empty, it was non-existence. Consciousness did not return whole, it came in fits and starts staggering back, dragging itself from the edge of the darkness in lurches and drunken convulsions. The first awareness was complete confusion. Where am I? What is going on? Who am I? The lack of self identity brought a formless fear with it.

There was light and dark and sound but no form, no reason. Then as my gaze wandered over the enclosure I began to recognize things. The TV screens with the flight simulation, the arc of the inside wall of the ball [centrifuge], the stick and throttle became identifiable articles. I knew what they were and there was less anxiety with the knowledge. As my consciousness lunged and reeled toward reality another feeling arose. I had a mission, something I must do. The need to complete my job sprung from some hidden crevice where it had been crushed out of sight. The light! The beeping! They had been in my view for ... how long? It seemed a long time. Only now they impinged full on my senses. I could see the light flash and then hear the steady loud beep, beep, beep. My job involved these things. I was to extinguish the light! The first impulse to move, to take action was, a surprise, a shock. My hand stabbed out, I had to put out the light, it was my mission! My arm wavered crazily and two or three frustrating stabs later the lighted button was pressed. The beep stopped, the light disappeared and the sequence that I was to follow crashed through the paper walls in my mind into the light of consciousness. I now knew what I was supposed to accomplish. I had a mission. Concentration was required to focus on the four numbers, and count them one by one as I fumbled through the sequence. Just as the fourth number disappeared my identity returned. I knew who I was! I was Tim Sestak! The relief, the release from tension and fear in the security of this knowledge was a physical rush. A warm fuzzy. I was safely myself. Now I knew why I was here, and what had happened. The sensation of loss of time was now very strong. It would remain so for hours, gradually fading, as if stepping back from the edge of the abyss but the memory is potent.

At the moment of self awareness and identity the sensation of loss of time, of having stepped from nothing directly into reality, was overwhelming. The non-existence was infinite, forever deep. I had been recreated after an eternity of nothing. There were memories of a time before but they were separated from NOW by the chasm of infinity. The final stages of consciousness oozed into place, gradually filling the little cracks and crevices of awareness. As normalcy returned, the only manifestation of the passage through the void was the coldness of memory. A psychic gasp and shudder came as the nothingness was re-examined. The feeling of loss was strong. Now my motor functions were near normal. I flew the simulation on, one part of me satisfied with the mission accomplishment, another aghast with the new found intimacy with the abyss.

Even now, nine hours later, the memory, though distanced in time, is no less potent. It carries with it an anxiety, an ill defined fear, and the aura of melancholy. Ambiguous feelings of loss well through a haze of mortality"

DISCUSSION

We need to be concerned with the state of mind of the G-LOC victim because his reaction to G-LOC will influence recovery. Symptoms such as confusion, convulsions, and dreaming may cover a brief time period (seconds). However, seconds are essential to survival when G-LOC occurs inflight. To understand G-LOC, we need to look at its induction and its recovery. Induction is based on physiology. Recovery is based in both the physiology and the psychology of the individual undergoing G-LOC.

Upon regaining consciousness, the subjects' motor and mental processes are not concurrently activated as demonstrated by the apparent transient paralysis during the early relative incapacitation period Unfortunately, the evidence of this transient paralysis is purely subjective. However, in the case of G-LOC, transient paralysis would probably not be detected by the majority of the subjects, because during early relative incapacitation, when this event would likely take place, the subject is undergoing a reorientation process consisting of extraordinary amounts of mental activity and motor action is apparently not yet a priority. The majority of the subjects do not "remember" (yet) that they are supposed to deactivate the warning signals immediately upon recovering consciousness. At this time, the subject is trying to understand what has just happened, and there is apparently no desire for any purposeful movement. Once the subject "remembers" to turn the warning signals "off" (at the end of the relative incapacitation period) the "paralysis prone period" has probably passed: the subject wants to and is able to deactivate the signals. Subjects who experience transient paralysis probably recognize the significance of the two warning signals during the paralysis prone period, but when they proceed to turn the signals off they temporarily are unable to do so. A reduction of the period of post-G-LOC confusion

probably experienced by these subjects may have been counter-balanced by the inability to move and deactivate the signals immediately upon recognizing their significance. It appears that transient paralysis is so fugacious that it might go unrecognized and, therefore, not reported. Also, if this phenomenon is recognized by the subjects, it might go unreported (as G-LOC is not always reported); probably for fear of it affecting the subject's flight-status or pride. One of the accepted methods of awakening patients suffering from sleep paralyses found in narcolepsy but a condition found also in G-LOC is the frank and vigorous shaking of the subject (the similarities of G-LOC transient paralyses and sleep paralyses, as a symptom of narcolepsy, have been previously discussed, 22). This method is currently not operationally feasible. Perhaps a minor electrical stimulation of the subject experiencing G-LOC is a solution suitable for consideration.

Nearly half of the subjects reported visual imageries occurring during their period of unconsciousness, the majority of these reports were labeled as dreams comparable to those experienced during normal sleep where the visual imageries had the following characteristics: emotion, illogical content, sensory impression, unconditional acceptance, and amnesia (29). The majority of the subjects reported "thinking," which is the most common activity during sleep and was mainly concerned with commonplace and recent events. Dream occurrence affects recovery. Do we want to manipulate their development during G-LOC? Is dreaming a protective mechanism? It has been suggested the purpose of dreaming includes the active maintenance of the functional integrity of the human brain. "By coordinating the activity of the cortex and spinal cord, the brain stem provides unifying control of our behavioral, physiological and mental states...In dreaming, the brain stem activates the cortex (arousing the mind), shuts off the spinal cord (blocking body movement), and sends signals to the eyes, to the cerebellum and to the visual brain

(stimulating imagery)". Indeed, dreams occurring during G-LOC may be regarded as the "reorganization of brain and mental activity, with intensification of some faculties mirrored by reduced activity of others, and both serving purposes as yet unclear but as likely to be productive as protective" (29). The G-LOC syndrome and its proposed mechanism has been discussed in the literature as an activation-inhibition hypothesis (57). Dreams are biologically based. The sensory and motor nature of dreams is directly related to the activation of the sensor and motor circuits of the brain; the emotion of dreams is possibly related to the limbic system; and dream amnesia is related to memory circuits (29). Hence, G-LOC dreams and subject behavior play a fundamental role in acceleration physiology research. Indeed, neurophysiologic studies on the dependence of the brain on the continuous supply of oxygen and glucose are based on the observation of patient behavior. These observations are then compared to a continuum of physiologic correlates in the brain.

It is also important to quantify the interpretation of the G-LOC warning signals and subject flailing since both are the first indication of G-LOC the subject encounters when recovering consciousness. Forty-nine percent of the subjects were confused or disinterested in the warning signals. Their effectiveness may be improved by changing the mode of their presentation (louder) or their nature altogether (voice as opposed to horn). However, the results presented above may be misleading since subject reaction to G-LOC in the centrifuge may not be compared to G-LOC inflight where the current signals may be sufficient. Operationally speaking, the occurrence of major flailing may also be of interest in that in the process of flailing, aircraft controls may be inadvertently activated (or deactivated). In summary, when G-LOC research is undertaken, it must consider the psychological sequelae of the event. These symptoms not only aid the researcher in developing better recovery methods based on subject psychology but also aid the physiologist in understanding the G-

LOC mechanism by considering the sequence of the symptoms, their timing, and the subjective interpretation of the same. Indeed, we must consider the G-LOC victim as more than a collection of viscera; as Popper et al stated, "to study how much G-tolerance the body has without considering the motivation, stress level, and all other variables influencing and individual's ability at any point in time (mind and spirit) leaves one with a plethora of data with questionable relevance" (43).

No information is available on the effect of G-LOC "experience" on incapacitation times. The proposed database would provide this information. One of the subjects stated: *"I wonder if mere repetition will quell the dissonance, breed the proverbial contempt through familiarity. At this point it seems unlikely. The natural aversion to the unknown and potentially dangerous actions grapples with a macabre curiosity. Can one voluntarily revisit the abyss and still be convinced he is wholly sane?"*. Indeed, to lose consciousness is an alarming proposal evidenced by all studies involving voluntary G-LOC where the subjects were always reluctant to lose control. However, to be familiar with its symptoms may be beneficial to the pilot recovering consciousness inflight, when seconds become essential to survival.

Limitations of the database: Variables that describe the timing of G-LOC events such as G-LOC onset, incapacitation, and convulsion times are subject to the particular investigator's interpretation of the G-LOC episode and how s/he defines G-LOC. That is, whereas one investigator may regard G-LOC onset as the point in time when the subject's eyes become fixated another investigator may regard it as the point in time when the subject loses neck muscle control instead. Hence, to evaluate variables of this type, the investigator needs to be extremely familiar with G-LOC symptomatology; familiarity being gained by observ-

ing numerous G-LOC occurrences. Also, when obtaining data of this type the investigator needs to confirm his findings by having other experienced observers evaluate the same.

Limitations of the questionnaire: 1) It would be argued that subject report data, such as the one contained in the G-LOC questionnaire is not as reliable as one would demand under scientific research methodology; especially when pilots are included as subjects since they may be under the impression that their careers would be affected if they report any "bizarre" or unusual sensations provoked by G-LOC. However, the G-LOC episodes are videotaped and anonymity attempts to prevent this problem. 2) The questionnaire provides highly subjective results that may be difficult to interpret. This is inherent of any subjective measure. However, the responses are valuable since these give an indication of how the subject interprets G-LOC and answering the questions themselves may aid the subject in evaluating and understanding his experience; the ultimate goal of centrifuge training. Indeed, it has been suggested G-LOC be part of the training schedule of GTIP programs since it could provide the subject with his unique characteristic symptoms pre and post G-LOC. Symptoms when promptly identified, could save the subject's life in the event of G-LOC inflight (58). 3) It has been difficult to administer the questionnaire immediately upon the subject awakening from G-LOC. Therefore, when asked, the subject may not remember exactly how he was reacting to the event. Generally, this problem is eliminated by asking the subject some of the questions briefly as he awakens (intercom system).

APPLICATIONS

The population of interest in aeromedical research is the aircrew member. It is rare to obtain information on this population, specially regarding G-LOC. The G-LOC questionnaire discussed herein and the results obtained from its contents provides a valuable and

simple way to study this population. Also, the questionnaire is a valuable tool to compile thorough large sample G-LOC research data that will allow the integration of both the physiology and the psychology of the G-LOC syndrome.

The questionnaire results in association with other G-LOC variables discussed above may be a source for developing training programs by assessing G-LOC incidence in the centrifuge, +Gz training methods, and the psychology of the G-LOC episode itself. Further, the questionnaire enhances training by making the subject aware of his particular symptoms (by recollecting the experience).

Symptoms occurring during recovery from G-LOC may lengthen G-LOC incapacitation periods. Hence, these symptoms are to be considered an integral part of G-LOC recovery.

The database can be expanded to include physiologic variables in such a way that these variables may be associated with the observable symptoms already included in the repository.

BIBLIOGRAPHY

1 Ades HW. Electroencephalographic findings in relation to episodes of altered consciousness in aviators. Aerosp. Med. 1962;33:263-274.

2 Albery WB, Van Patten RE. Non-invasive sensing systems for acceleration induced central nervous system ischemia. IEEE Eng. in Med. and Biol. Mag. 1991;10:46-51.

3 Babbit BA, Nystrom CO. Questionnaire Construction Manual. Research Product 89-20, U.S. Army, June 1989.

4 Beckman EL, Duane TD, Ziegler JE, Hunter HN. Some observations on human tolerance to accelerative stress. Aviat. Med. 1954;25:50-65.

5 Berkhout J, O'Donnell RD, Leverett S. Changes in electroencephalogram spectra during repeated exposure to +Gz acceleration. Report AMRL-TR-72-123, 1972.

6 Burns JW. Prevention of loss of consciousness with positive pressure breathing and supinating seat. Aviat. Space and Environ. Med. 1988;59:20-22.

7 Burns JW, Balldin UI. Assisted positive pressure breathing for the augmentation of acceleration tolerance time. Aviat. Space Environ. Med. 1988;59:225-233.

8 Burns JW, Whinnery JE. Significance of headrest geometry in +Gz protective seats. Aviat. Space Environ. Med. 1984;55:122-127.

9 Burton RR, Cohen MW, Guedry FE. G-induced loss of consciousness: a panel presentation. Proc. Ann. Meet. Aerosp. Med. Assoc. 1986.

10 Burton RR, Meeker LJ, Raddin JH. Centrifuges for studying the effects of sustained acceleration on human physiology. IEEE Eng. in Med. and Biol. Mag. 1991;10:56-65.

11 Cammarota JP. Integrated systems for detecting and managing acceleration induced loss of consciousness. IEEE Eng. in Med. and Biol. Mag. 1991;10:52-55.

12 Cammarota JP. Research in a high-fidelity acceleration environment. Proc. Natl. Aerosp. Elec. Conv. 1989:778-782.

13 Cammarota JP. Symptoms of +Gz induced incapacitation during simulated aerial combat. Aviat. Space Environ. Med. 1991;62:485.

14 Cammarota JP, Whinnery JE. Enhancing centrifuge high G training using on-line videotape documentation. Aviat. Space Environ. Med. 1990;61:1153-1159.

15 Clère JM, Patat F, Ossard G, Lejeune D, Arbeille PH, Besse G. Simultaneous doppler measurement of femoral and carotid blood velocity: +Gz acceleration effect. Aviat. Space Environ. Med. 1991;62:476.

16 Cohen GH, Brown WK, Electrocardiographic changes during positive acceleration. J. Appl. Physiol. 1969;27:858-862.

17 Edelberg R, Henry TP, Macioleck JA, Salzman EW, Zuidema GD. Comparison of human tolerance to accelerations of slow and rapid onset. Aviat. Med. 1956;12:482.

18 Forster EM. Heart rate response of aircrew during recovery from gradual onset +Gz exposures. Aviat. Space Environ. Med. (in press).

19 Forster EM, Cammarota JP, Whinnery JE. G-LOC recovery with and without anti-g suit inflation. Aviat. Space Environ. Med. (undergoing review by the journal editors).

20 Forster EM, Cammarota JP. The effects of GLOC on psychomotor performance and behavior. Aviat. Space Environ. Med. 1993;64:132-138.

21 Forster EM, Fischer JR. The dream phenomena during GLOC. Aviat. Space Environ. Med. 1989;60:490.

22 Forster EM, Whinnery JE. Recovery from +Gz induced loss of consciousness: psychophysiologic considerations. Aviat. Space Environ. Med. 1988;59:517-522.

23 Forster EM, Whinnery JE. Reflex heart rate response to variable onset +Gz. Aviat. Space Environ. Med. 1988;59:249-254.

24 Gillingham KK, Fosdick JP. High G training for fighter aircrew. Aviat. Space Environ. Med. 1988;59:12-19.

25 Glaister DH. Current and emerging technology in G-LOC detection: noninvasive monitoring of cerebral microcirculation using near infrared. Aviat. Space Environ. Med. 1988;59:23-28.

26 Guyton AC, ed. Textbook of Medical Physiology. Philadelphia: WB Saunders, 1981.

27 Haswell MS, Jöbsis FF. Non-invasive physiologic brain monitoring in USAF operational environments. Proc. SAFE 22nd Ann. Symp. 1984;200-203.

28 Henry JP, Gauer OH, Kety SS, Kramer K. Factors maintaining cerebral circulation during gravitational stress. J. Clin. Invest. 1951;30:292-300.

29 Hobson JA. The Dreaming Brain. New York: Basic Books, 1988.

30 Houghton JO, McBride DK, Hannah K. Performance and physiological effects of acceleration induced (+Gz) loss of consciousness. Report NADC-86130-60.

31 Howard P. Gravitational Circulation. Proc. Ann. Meet. Royal Soc. Lon. 1977;199:485-491.

32 Hrebrien L, Eyth J, Bernard GW. Tactical aircrew G-strain familiarization study. Report NADC-87021-60, 1987.

33 Jöbsis FF. Non-invasive infrared monitoring of cerebral and myocardial oxygen sufficiency and circulatory parameters. Science 1977;198:1264-1267.

34 Johanson DC, Pheeny HT. A new look at the loss of consciousness experience within the U.S. Naval forces. Aviat. Space Environ. Med. 1988;59:6-8.

35 Krutz RW, Burton RR, Forster EM. Physiologic correlates of protection afforded by anti-G suits. Aviat. Space Environ. Med. 1990;61:106-111.

36 Krutz RW, Rossitano SA, Mancini RE. Comparison of techniques for measuring +Gz tolerance in man. J. Appl. Physiol. 1975;38:1143-1145.

37 Leverett SD, Whinnery JE. Biodynamics: sustained acceleration. In: DeHart RL, ed. Fundamentals of Aerospace Medicine. 1st ed. 1985:202-249.

38 Lewis NL, McGovern JB, Miller JC, Eddy DR, Forster EM. EEG indices of G-induced loss of consciousness (G-LOC). AGARD Report 432, 1988.

39 Lyons TJ, Harding R, Freeman J, Oakley C. G-induced loss of consciousness accidents: USAF experience: 1982-1990. Aviat. Space Environ. Med. 1992;63:60-66.

40 Njemanze PC. Transcrannial doppler evaluation of syncope: an application in aerospace physiology. Aviat. Space Environ. Med. 1991;62:569-572.

41 Moore TW, Jaron D. Cardiovascular model for studying circulatory impairment under acceleration. IEEE Eng. in Med. Biol. Mag. 1991;10:37-40.

42 Ossard G, Clère JM, Lejeune D, Roncini A, Léger A. Can we detect G- loss of consciousness by transcrannial doppler investigation? Aviat. Space Environ. Med. 1990;61:470.

43 Popper SE, McCloskey K. Individual differences and subgroups within populations: the shopping bag approach. Aviat. Space Environ. Med. 1993;64:74-77.

44 Powell TJ, Carey TM, Brent HP, Taylor WJR. Episodes of unconsciousness in pilots during flight in 1956. Aviat. Med. 1957;Aug:374-386.

45 Rourke JE. Questionnaire and Interview Design (Subjec ive Testing Techniques). TECOM Pam 602-1, Vol 1, U.S. Army, July, 1975.

46 Sandler H, Rossitano SA, McCutcheon EP. An objective determination of +Gz acceleration tolerance. Acta Astronautica 1977;4:451-553.

47 Scheaffer RL, Mendenhall W, Ott L, eds. Elementary Survey Sampling. Boston: PWS-KENT, 1990.

48 Shahed AR, Barber JA, Aldape FA, Werchan PM. Acceleration induced effects on baboon blood chemestry. Aviat. Space Environ. Med. 1991;62:463.

49 Shahed AR, Werchan PW. Cerebral biochemical basis of +Gz induced loss of consciousness (G-LOC). Aviat. Space Environ. Med. 1992;63:424.

50 Shubrooks SJ. Changes in cardiac rhythm during sustained high levels of positive (+Gz) acceleration. Aerosp. Med. 1972;43:1200-12006.

51 Squires RD. Electroencephalographic changes in human subjects during blackout produced by positive acceleration. Report NADC-ML-6402, 1964

52 Werchan PM. Physiologic basis of G-induced loss of consciousness (G-LOC). Aviat. Space Environ. Med. 1991;62:612-614.

53 Werchan PM, Forster EM. Transcrannial doppler quantitation of G protection. Aviat. Space Environ. Med. 1990;61:471.

54 Werchan PM, Laughlin MH, Schadt JC, Fanton JW, Burns JW, Burton RR. Microsphere and flowprobe measurements of cerebral blood flow (CBF) during acceleration. Aviat. Space Environ. Med. 1989;60:504.

55 Whinnery CM, Whinnery JE. The effect of +Gz offset rate on recovery from acceleration induced loss of consciousness. Aviat. Space Environ. Med. 1990;61:929-934.

56 Whinnery JE. Observations on the neurophysiologic theory of acceleration (+Gz) induced loss of consciousness. Aviat. Space Environ. Med. 1989;60:589-593.

57 Whinnery JE. Theoretical analysis of acceleration induced central nervous system ischemia. IEEE Eng. in Med. and Biol. Mag. 1991;10:41-45.

58 Whinnery JE, Burton RR. +Gz induced loss of consciousness: a case for training exposure to unconsciousness. Aviat. Space Environ. Med. 1987;58:468-472.

59 Whinnery JE, Hamilton RJ, Cammarota JP. Techniques to enhance safety in acceleration research and fighter aircrew training. Aviat. Space Environ. Med. 1991;62:989-993.

60 Whinnery JE, Jones DR. Recurrent Gz induced loss of consciousness, psychologic considerations. Aviat. Space Environ. Med. 1987;58:943-947.

61 Whinnery JE, Slaughter JW. A computerized repository system for collection and retreival of acceleration stress research data. Meth. Infrom. Med. 1981;20:10-15.

62 Whinnery JE, Whinnery AM. Acceleration induced loss of consciousness - a review of 500 episodes. Report NADC-88100-60, 1988.

63 Whitley PE. Integrated protective systems for operational acceleration-induced loss of consciousness. IEEE Eng. in Med. and Biol. Mag. 1991;10:66-75.

64 Wood EH. Prevention of the pathophysiologic effects of acceleration in humans: fundamentals and historic perspectives. IEEE Eng. in Med. and Biol. Mag. 1991;10:26-36.

65 Wood EH, Lambert EH, Code CF. The hydro- and resulting bio-dynamics of +Gz induced loss of consciousness and its history. Proc. Natl. Aerosp. Conf., Dayton, OH, May 1987.

66 Zhang S, Hong-Shang G, Bai-Sheng J, Song-Feng L. The characteistics and significance of intrathoracic and abdominal pressures during Quigong (Q-G) maneuvering. Aviat. Space Environ. Med. 1992;63:785-788.

APPENDICES

APPENDIX A

APPENDIX A

DESCRIPTION OF THE DATABASE

VARIABLE DEFINITION: A brief description of the variable precedes its format definition. Note: input format is intended for SAS™ statistical package. The following are described for each variable when required:

Field	Refers to the number of characters allowed for the entry field.
Missing	Refers to the value used to denote missing data.
Character	Describes the characters of the variable: Alpha, and/or Numeric.
N/A	Refers to the value used to denote non-applicable data.
Value	Arabic/roman numerals: measured (M - how measured) or calculated (C - how calculated) or assigned (A - by whom).Decimal As in whether there are any expected.
Range	Variable range.
Units	Variable measurement units.
{ }	brackets enclose variable numbers.

VARIABLE SELECTION: The variables included in the database were classified into four types.

I Subject description in general.

{1} PUNTO
{2} AGTIP
{4} DATE
{5} LOCTAPE
{6} TAPECT
{32} DREAMQ
{35} TOYINCER
{59} SLEEPARY
{61} ERELOC
{62} ERELOCN
{63} ERELOCWH
{69} DREMRCA
{70} AGE
{71} WEIGHT
{72} HEIGHT
{73} JOB
{76} GENDER
{77} AEROBIC
{78} ANAEROBI
{79} WORK
{80} AIRCRAFT

II Acceleration profile / study characteristics

{3} STUDY
{7} BASEG
{8} MAXG
{11} RELTOL
{12} TIMAX
{13} TIMG
{15} TIMEND
{16} TMAX
{23} GSUIT
{24} SEAT
{25} STRAIN
{31} PROFILE
{33} JOESUIT
{74} PPBPBG
{83} CENTRIFU

III G-LOC description.

{9} GOFLOC
{10} WHENLOC
{14} LOCINDTI
{17} CONINDTI
{18} CONVTIM
{19} CONVTYP
{20} ABSOLUTE
{21} RELATIVE
{22} TOTAL
{26} PLL
{27} BREATHE
{28} PIGTIME
{30} LOCTYP
{34} TOYINCAP
{36} POSITION
{37} CNVTMAWK
{39} MOTSICK
{53} BLACKOUT
{60} FLAILING
{82} FLALAWAR

IV Psychologic sequelae of G-LOC.

{29} EVENT
{38} AMNESIA
{40} EUPHORIA
{41} EMBRSMNT
{42} DENIAL
{43} ANGER
{44} CONFUSED
{45} RELAX
{46} FRIGHT

{47} APATHY
{48} FRUSTRAT
{49} SADNESS
{50} SORPRESA
{51} OTHER
{52} SURPRISE
{54} WHEREAMI
{55} GUESSUCS
{56} HORNUCS
{57} HORNOFF
{58} HORNWHY
{64} EVENTQUA
{65} EVENTACT
{66} EVENTINT
{67} EVENTELM
{68} SLIPDREM
{75} EVQUAL
{81} DREMWHR

VARIABLE DESCRIPTION:

1. PUNTO

An I.D. number, unique for each subject (S). Some Ss experienced more than 1 G-LOC episode. Therefore, a particular PUNTO may appear more than once.

Field: 3
Missing: never
Character: numeric
N/A: never
Value: arabic (A - author)
Range: 1 -

2. AGTIP

An additional subject I.D. number, unique for each G-Tolerance Improvement Program (GTIP) trainee. Non-GTIP subjects are identified by name. For a description of the GTIP program contact AVCSTD, NAWCADWAR, Warminster, PA 18974-5000 (NAWC): D. Murray, (215)-441-3954. The AGTIP I.D. number is identical to the I.D. number assigned to the subject in the NAWC GTIP database (for information on the NAWC GTIP database, contact the author).

Field: 10
Missing: z
Character: alphanumeric
N/A: never
Value: letters and arabics (A - author)
Range: 1 -

3. STUDY

Reason for the acceleration exposure. For further information on the particulars of each specific research study contact the principal investigator / responsible party at NAWC, Code 6023 (names are enclosed in brackets).

GTIP	GTIP training	[NAWC Flight Surgeon]
AILSS	Advanced Integrated Life Support System	[P. Whitley]
PROF	Proficiency run	[NAWC Flight Surgeon]
FUNK	Functional Buffer Period	[J. Cammarota]
ACES	Voluntary G-LOC	[J. Cammarota]
DCIM	PPB/PBG DCEIM	[P. Whitley]
TLSS	Tactical Life Support System.	[P. Whitley]
PALE	Pelvis And Legs Elevated	[P. Whitley]
MEDEV	Medical Evaluation	[NAWC Flight Surgeon]
RES	Other research.	
LGLOC	Voluntary G-LOC	[N. Lewis-Miller, c/o Capt. Miller, Brooks AFB, San Antonio TX 78235]
WGLOC	Voluntary G-LOC	[J. Whinnery, Mail Stop #18, Andrews AFB, MD 20331]
FLITE	G-LOC inflight [anecdotal]	

Field: 5
Missing: z
Character: alpha
N/A: never
Value: (A - author)
Range: see above

4. DATE

Date when the acceleration exposure occurred.

Field: 4
Missing: 0
Character: numeric
N/A: never
Value arabic
Units month (first 2 digits) year (last 2 digits)

5. LOCTAPE

Master G-LOC video tape number (where the subject's G-LOC is recorded). VHS format.

Field 3
Missing z
Character alpha
N/A z
Value roman (A - author)
Range I-

6. TAPECT

Tape count (Sony model VP7020 or Sony model VO5800 recorder/player) on master tape {5} above.

Field 5
Missing never
Character numeric
N/A 10000
Value arabic (M - Sony recorder/player digital reading)
Range 0000-6000
Units minutes (first two digits) seconds (last two digits)

7. BASEG

Base +Gz level before and after the exposure (Figure A1).

Field	3
Missing	0.0
Character	numeric
N/A	never
Value	arabic (M - video screen display)
Decimals	one
Range	1.0
Units	+Gz

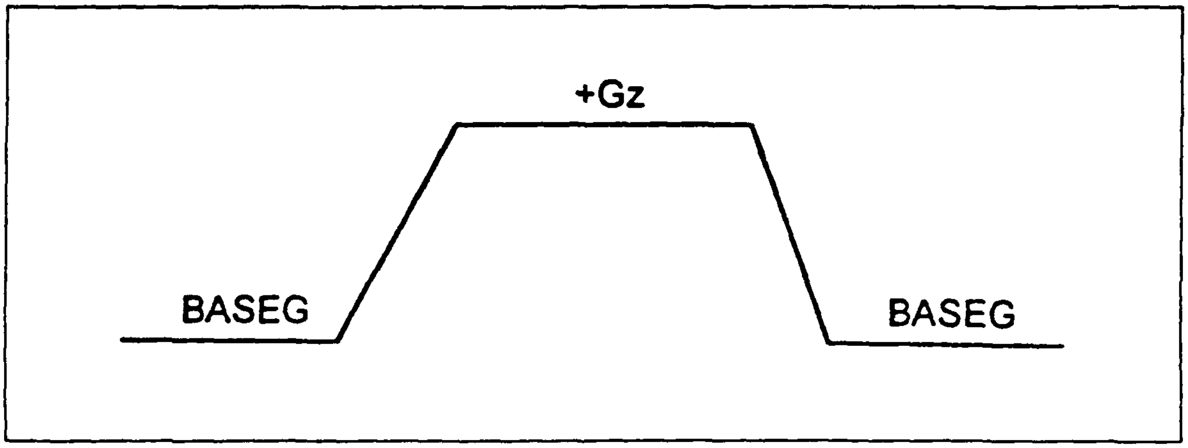


Figure A1. BASEG Description

8. MAXG

Maximum +Gz of the entire exposure (Figure A2). For STUDY {3} = ACES, this variable denotes the maximum +Gz of the entire engagement that led to G-LOC. Permutation variables: GMAX and GXAM.

GMAX = 7	when MAXG < 7
GMAX = 9	when MAXG >= 7

GXAM = 5	when MAXG 4.5 to < 5.5
GXAM = 6	when MAXG 5.5 to < 6.5
GXAM = 7	when MAXG 6.5 to < 7.5
GXAM = 8	when MAXG 7.5 to < 8.5
GXAM = 9	when MAXG 8.5 to < 9.5

Field	3
Missing	0.0
Character	numeric
N/A	never
Value	arabic (M - video screen display)
Decimals	one
Range	> 1 -
Units	+Gz

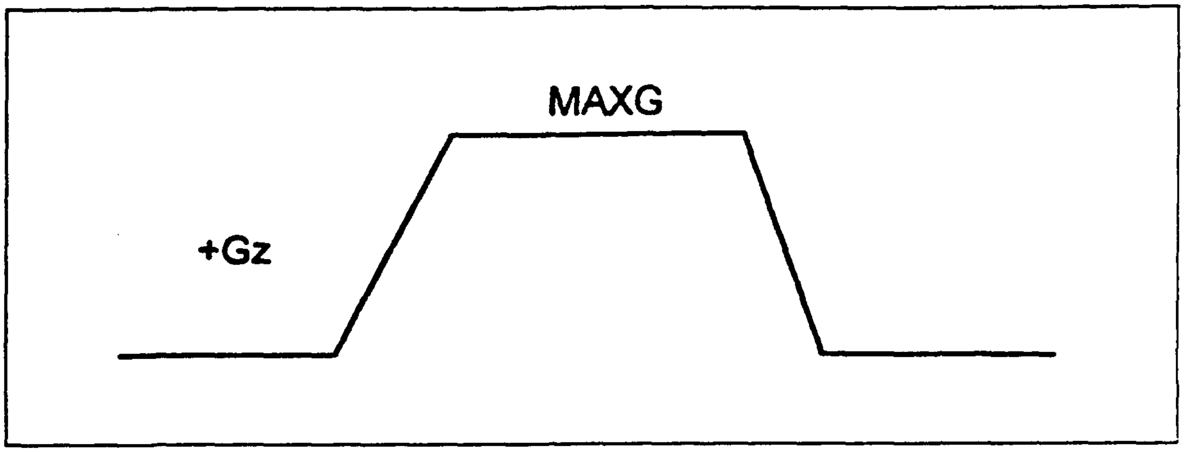


Figure A2. MAXG Description

9. GOFLOC

+Gz when G-LOC occurred (Figure A3).

Field	3
Missing	0.0
Character	numeric
N/A	never
Value	arabic (M - video screen display)
Decimals	one
Range	1.0
Units	+Gz

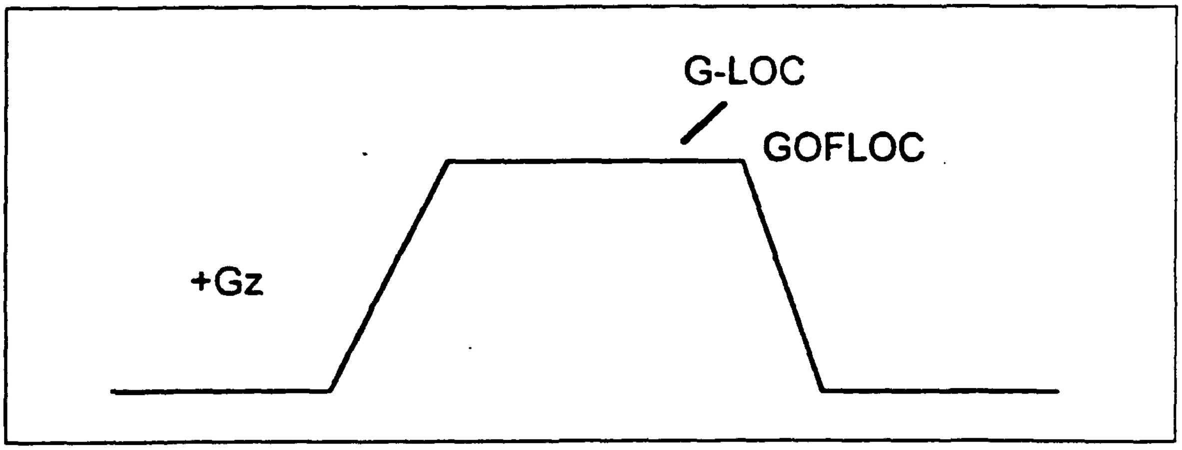


Figure A3. GOFLOC Description

10. WHENLOC

When, during the exposure, G-LOC occurred as follows (Figure A4):

P	at maximum +Gz, during plateau
U	during acceleration ("up")
D	during deceleration ("down")
B	at base +Gz, after the exposure

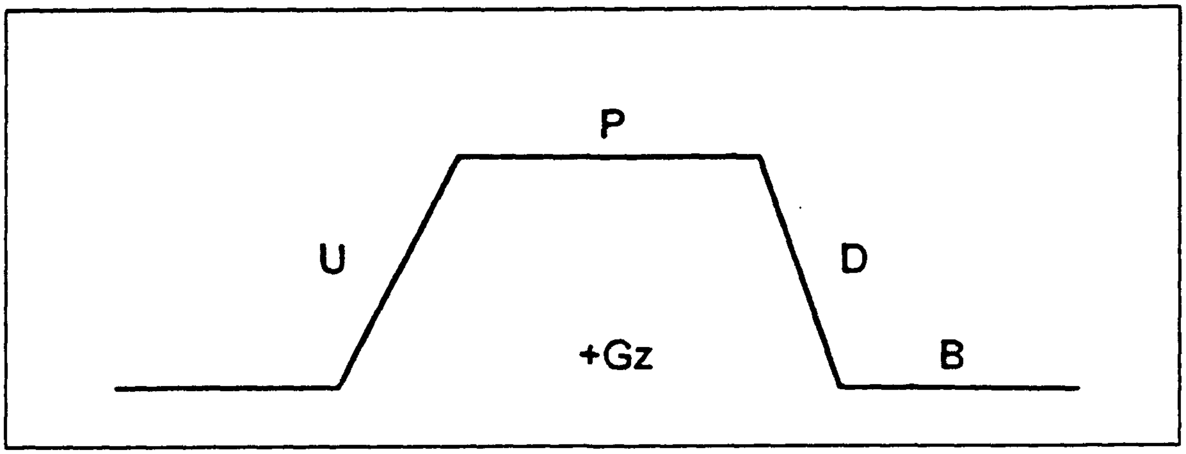


Figure A4. WHENLOC Description

Field	1
Missing	z
Character	alpha
N/A	never
Value	(A - author, video screen observation)
Range	see above

11. RELTOL

Relaxed tolerance of the subject (Figure A5). +Gz level when subject started straining (due to 60 degrees from the vertical peripheral light loss) during a GOR exposure (see PROFILE {31}). For a description of the standard protocol, see introduction.

Field	3
Missing	0.0
Character	numeric
N/A	never
Value	arabic (M - video screen observation)
Decimals	one
Range	>1.0 -
Units	+Gz

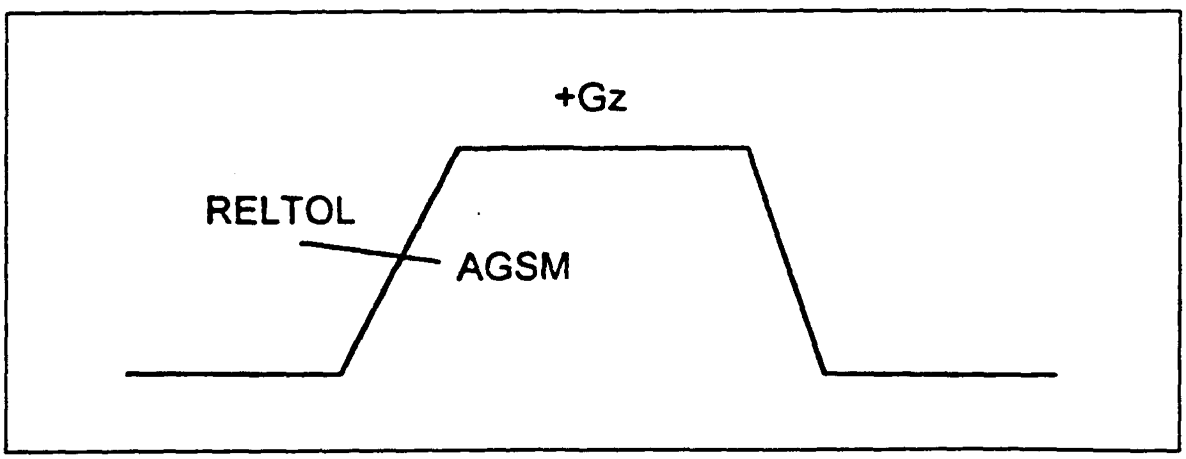


Figure A3. RELTOL Description

12. TIMAX

Time to maximum +Gz from BASEG {7} to the onset of MAXG {8} (Figure A6). For STUDY {3} = ACES, this variable denotes the total engagement time of the particular exposure that led to G-LOC.

Field	2
Missing	0
Character	numeric
N/A	never
Value	arabic (M - video screen observation)
Decimals	none
Range	> 0
Units	seconds

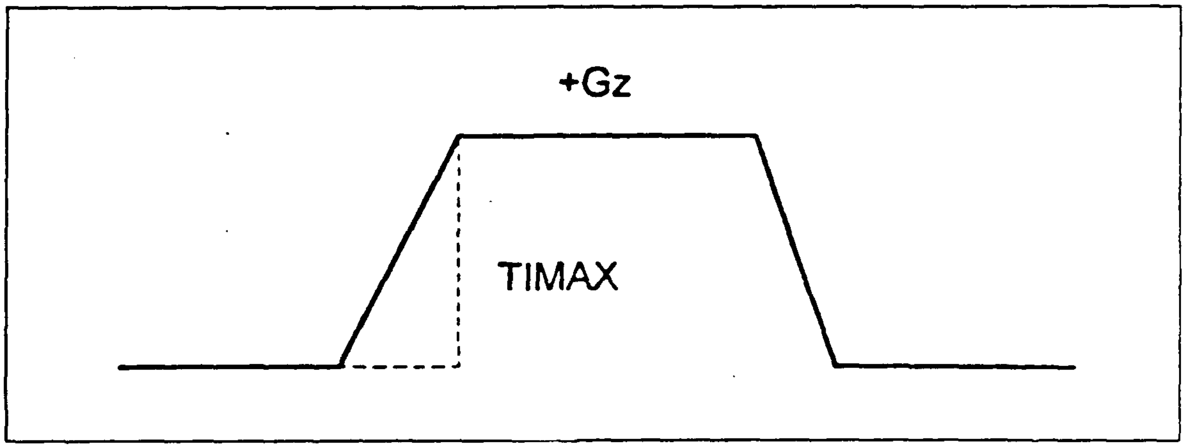


Figure A6. TIMAX Description

13. TIMG

Total time of +Gz exposure from BASEG {7} (ere exposure) to BASEG {7} (aft exposure) (Figure A7). For STUDY {3}= ACES, this variable denotes the total engagement time of the entire experimental day.

Field	2
Missing	0
Character	numeric
N/A	never
Value	arabic (M - video screen observation)
Decimals	none
Range	> 0
Units	seconds

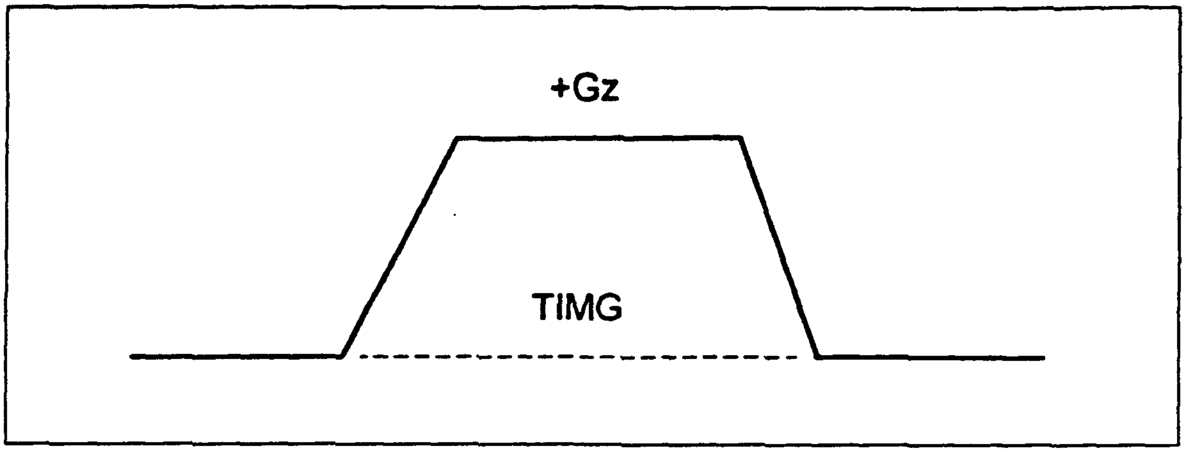


Figure A7. TIMG Description

14. LOCINDTI

G-LOC induction time: from BASEG {7} to G-LOC (Figure A8).

Field	2
Missing	0
Character	numeric
N/A	never
Value	arabic (M - video screen observation)
Decimals	none
Range	> 0
Units	seconds

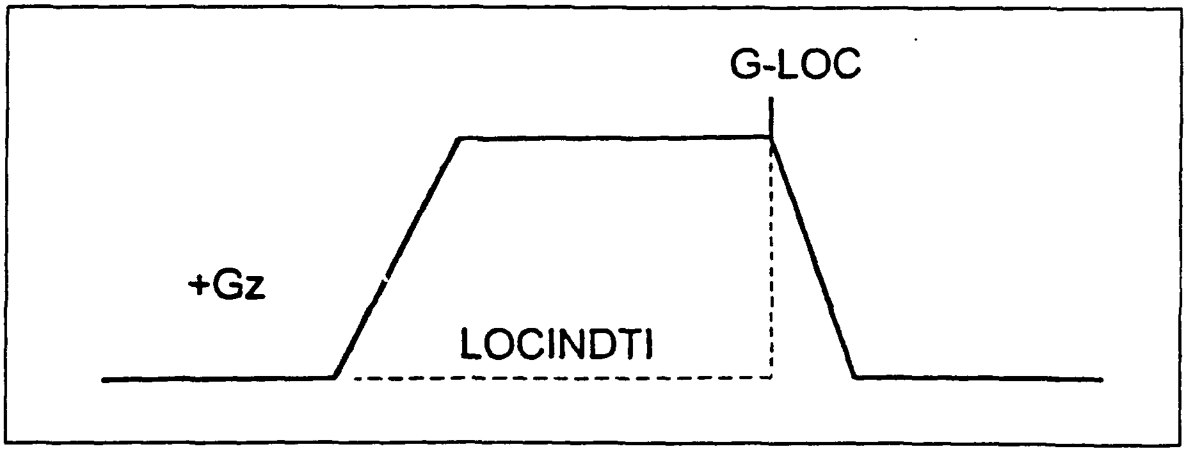


Figure A8. LOCINDTI Description

15. TIMEND

Time from the end of MAXG {8} to BASEG {7} (Figure A9).

Field	2
Missing	0
Character	numeric
N/A	never
Value	arabic (M - video screen observation)

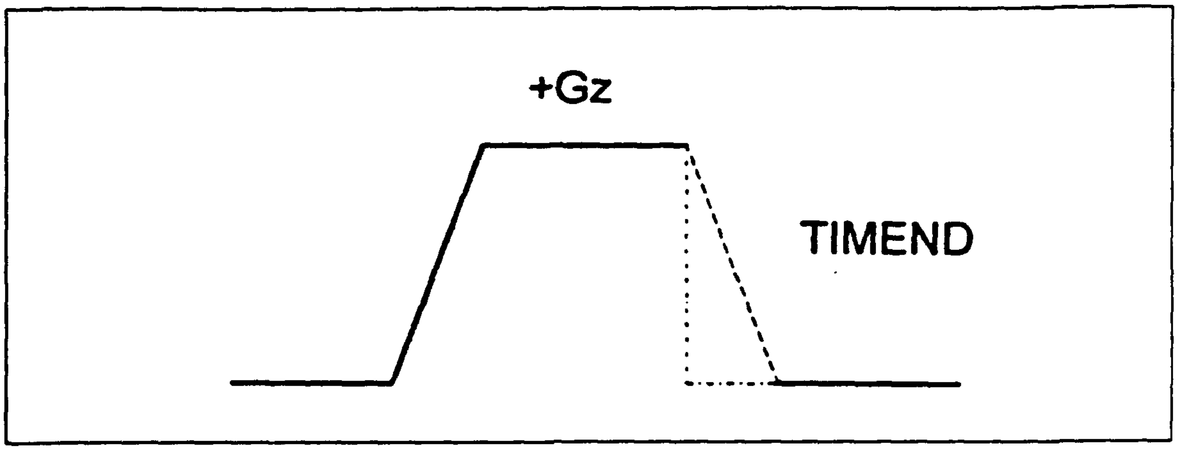


Figure A9. TIMEND Description

Decimals	none
Range	> 0
Units	seconds

16. TMAX

Time at MAXG {8} (Figure A10). For STUDY {3} = ACES, this variable denotes the time at MAXG {8} of the engagement that led to G-LOC.

Field	3
Missing	0
Character	numeric
N/A	100 (GOR exposures)
Value	arabic (M - video screen display)
Decimals	none
Range	> 0
Units	seconds

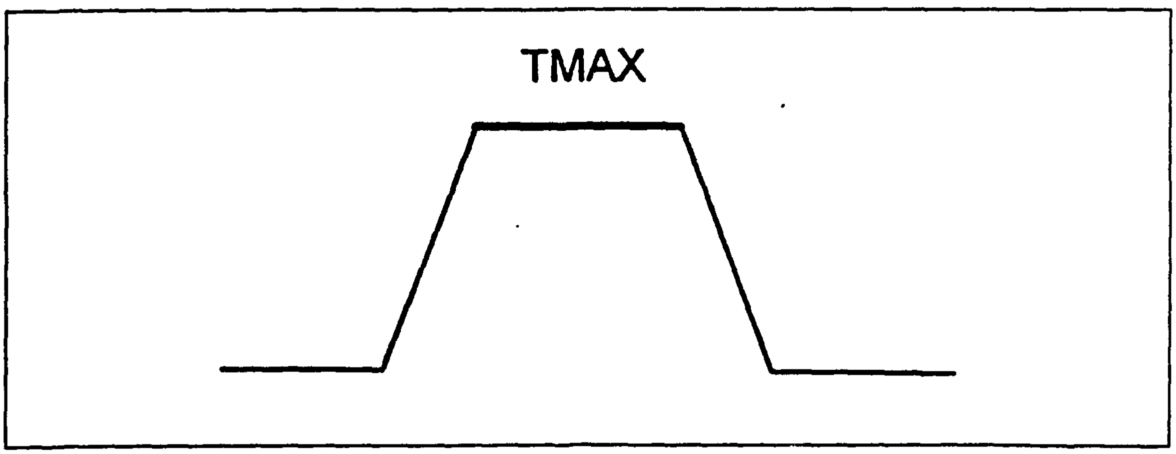


Figure A10. TMAX Description

17. CONINDTI

Convulsion induction time from G-LOC to the moment the subject starts convulsing - any type of convulsion/twitch (Figure A11).

Field	3
Missing	99
Character	numeric
N/A	100 (subject did not convulse/flail)
Value	arabic (M - video screen observation)
Decimals	none
Range	may be negative
Units	seconds

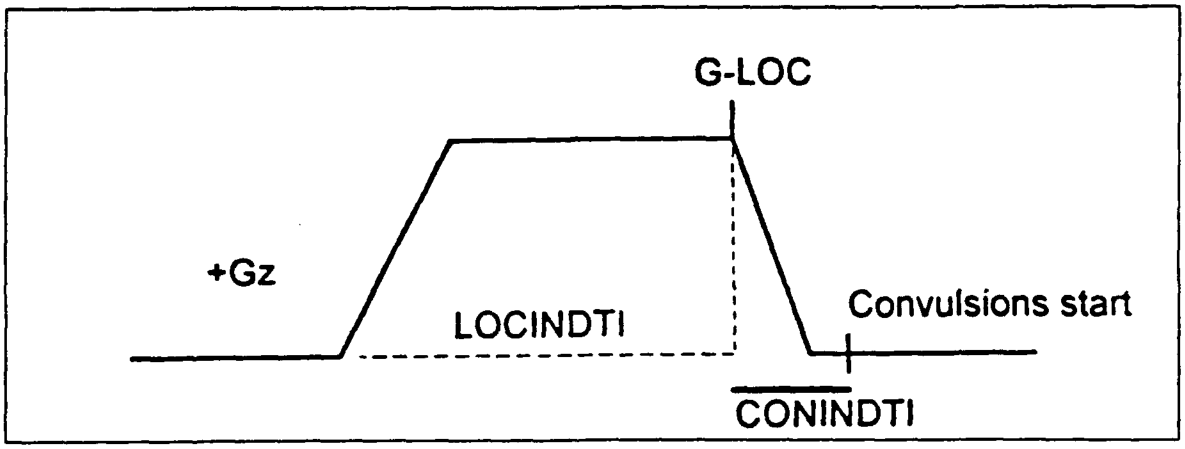


Figure A11. CONINDTI Description

18. CONVTIM

Convulsion time as in its duration (including "silent" moments between convulsions). From the moment the subject starts convulsing to the moment convulsions are no longer apparent (Figure A12).

Field	3
Missing	0
Character	numeric
N/A	100 (subject did not convulse/flail)
Value	arabic (M - video screen observation)
Decimals	none
Range	> 0
Units	seconds

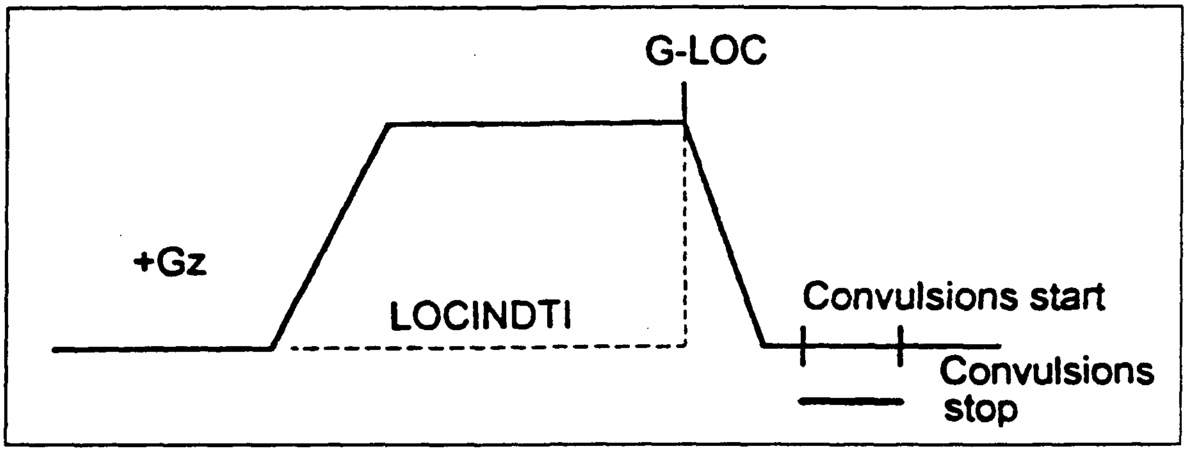


Figure A12. CONVTIM Description

19. CONVTYP

Convulsion type as follows:

MAJOR	obvious flailing/major jerks - usually myoclonic
MEDIUM	same as above but not as intense
MINOR	twitch/slight movements - usually mimic (face)

Field	6
Missing	miss
Character	alpha
Value	(A - author, video tape observation)
N/A	NO (subject did not convulse/flail)
Range	see above

20. ABSOLUTE

Absolute incapacitation. From: S's eyes roll back / close (obvious G-LOC state) To: S's eyes focused / blinking / nonstaring / open. This variable refers to the period of time when the subject is obviosuly absolutely incapacitated / unconscious (Figure A13).

Field	3
Missing	0
Character	numeric
N/A	never
Value	arabic (M - video tape observation)
Decimals	none
Range	> 0
Units	seconds

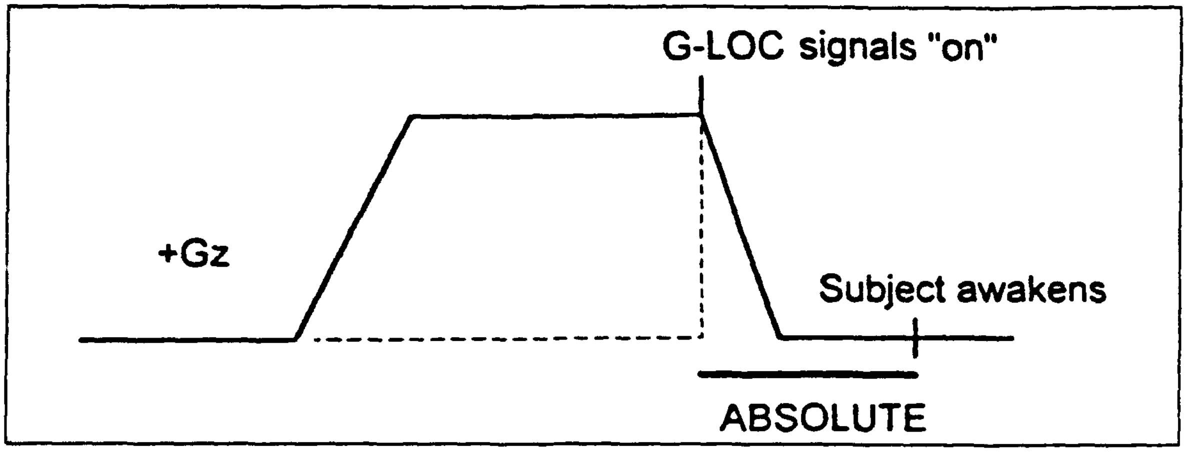


Figure A13. ABSOLUTE Description

21. RELATIVE

Relative incapacitation. From end point of ABSOLUTE {20} to extinguishing (as instructed) warning signals (light and horn) activated by a monitor (investigator / M.D.) upon recognition of G-LOC. For a description of the warning signals, please refer to reference 53. This variable refers to the period of time when the subject has awakened from G-LOC but is confused as to his surroundings and essentially unable to perform (Figure A14).

Field	3
Missing	0 (horn not activated or S prompted to deactivate)
Character	numeric
N/A	never
Value	arabic (M -video tape observation)
Decimals	none
Range	> 0
Units	seconds

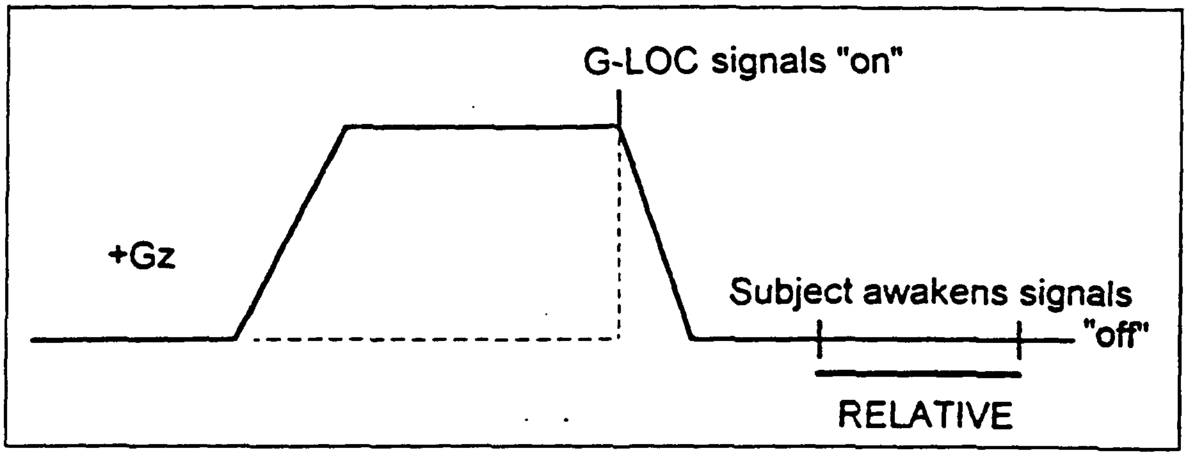


Figure A14. RELATIVE Description

22. TOTAL

Total incapacitation. Sum of ABSOLUTE {20} and RELATIVE {21} incapacitations (Figure A15).

Field	3
Missing	0 (horn not activated or S prompted to deactivate)
Character	numeric
N/A	never
Value	arabic (C: {20} + {21}, video tape observation)
Decimals	none
Range	> 0
Units	seconds

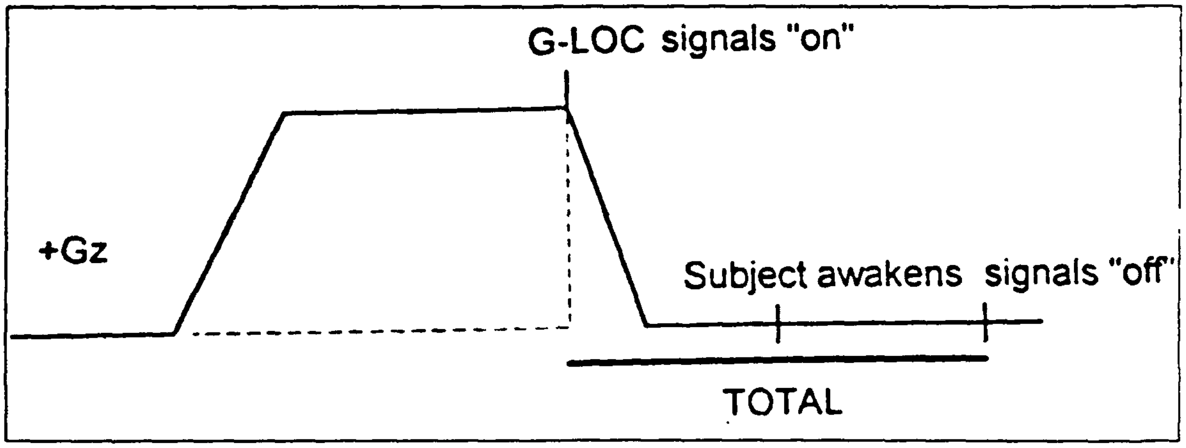


Figure A15. TOTAL Description

23. GSUIT

Was the subject wearing an activated G-suit? Note: for STUDY {3}= GTIP the G-suit is CSU15\P and is usually worn by all subjects. Check: GOR exposures (see PROFILE {31}, usually do not entail an inflated G-suit).

Value	logical (data sheet)
N/A	never (as in most T/F variables)
Range	T/F

24. SEAT

Seat angle from the vertical. Check: Early GTIP (see STUDY {3}) entries may have 30 degrees as an entry. Later, 15 degrees is expected as an entry for this type of exposures.

Field	2
Missing	0
Character	numeric
N/A	never
Value	arabic (data sheet)
Decimals	none
Range	> 0
Units	degrees

25. STRAIN

Did the subject perform anti G straining maneuvers during the exposure? Note that straining during GOR (see PROFILE {31}) begins at RELTOL {11}. Check: to agree with STUDY {3},

Field	1
Missing	z
Character	alpha
Value	logical (data sheet)
N/A	never (as in most T/F variables)
Range	T/F

26. PLL

Last peripheral light loss recalled by the subject (ere G-LOC).

Field	3
Missing	99 (S not asked)
Character	numeric
N/A	never
Value	arabic (A - by S. data sheet)
Decimals	none
Range	0-90
Units	degrees

27. BREATHE

Highly noticeable breathing symptoms i.e., snorting/ moaning/ yelling— Did these occur?

Field	1
Missing	z
Character	alpha
Value	logical (A - video tape observation)
N/A	never (as in most T/F variables)
Range	T/F

28. PIGTIME

When did symptoms above {27} occur (from the onset of G-LOC).

Field	3
Missing	0
Character	numeric
N/A	100 (when BREATHE {27} = F)
Value	arabic (M - video tape observation)
Decimals	none
Range	may be negative
Units	seconds

29. EVENT

Illusions/Imageries experienced while the subject was unconscious as reported on the video tape or G-LOC questionnaire as follows: Permutation variable: EVENTO:

NONE	none
DREM	dream
THOT	thoughts
CANT	cannot remember

EVENTO =	ILLU	when EVENT = DREM/THOT
EVENTO =	NOILLU	when EVENT = NONE/CANT

Field 4
Missing z
Character alpha
N/A never
Range see above

30. LOCTYP

G-LOC type as follows:

GLOC true, obvious, classic G-LOC
TRANS transient, similar symptoms as G-LOC but less obvious.
LOCO "I was'nt here"/"I'm back" syndrome, muscle twitching only, GI square (as defined by ACES protocols labeled by J. Cammarota). Is it a G-LOC?

Field 5
Missing z
Character alpha
Value logical (A - author, video tape observation)
N/A never
Range see above

31. PROFILE

+Gz profile as follows (for STUDY {3}= FUNKY, PROFILE was usually a combination of both GOR and ROR, in these cases, ROR was entered) (Figure A16).

GOR gradual onset rate (0.1 +Gz/s)
ROR rapid onset rate (=> 1.0 +Gz/s)
RORX rapid onset rate, "check 6" position (head turned 90 degrees)

Field 4
Missing z
Character alpha
Value logical (A. data sheet)
N/A never
Range see above

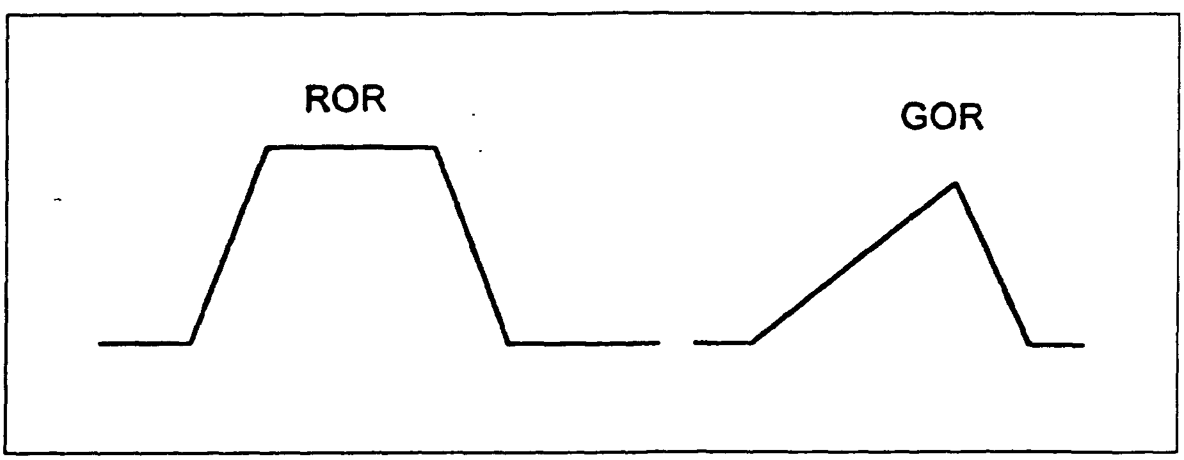


Figure A16. PROFILE Description

32. DREAMQ

Dream questionnaire (G-LOC questionnaire) number.

Field	3
Missing	never
Character	numeric
N/A	0 (no questionnaire given)
Value	arabic (A - author, questionnaire)
Decimals	none
Range	> 0

33. JOESUIT

Was the G-suit inflated (to 10 psi) upon G-LOC (deflation = 15 s) This variable refers to a modified G-suit inflation rate upon G-LOC proposed by J. Cammarota and J. Whinnery in 1990 (Reference 17), Figure A17.

Field	1
Missing	z
Character	alpha
Value	logical (video tape observation)
N/A	never (as in most T/F variables)
Range	T/F

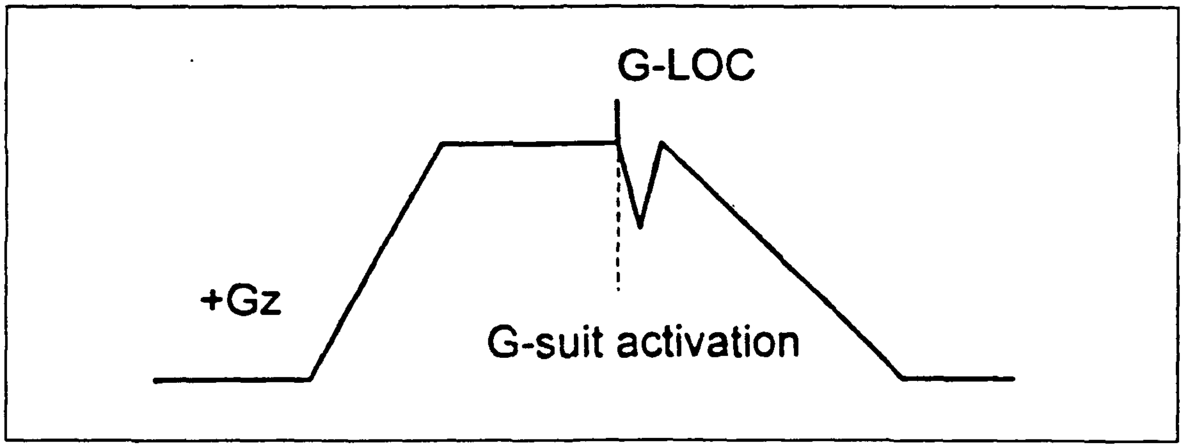


Figure A17. JOESUIT Description

34. TOYINCAP

Total incapacitation according to the video screen {5} when the subject was not prompted to deactivate the warning signals. Check: 21, 56-58. Time is measured from the activation of the G-LOC warning signals by the medical monitor until the deactivation of the same by the S.

Field	4
Missing	0 (horn not activated)
Character	numeric
N/A	0 (see missing)
Value	arabic (M - video tape display)
Decimals	one
Range	> 0
Units	seconds

35. TOYINCER

Total "incapacitation" prior to the exposure (as shown in the computer screen - see above) when the subject is introduced to the master caution signals, i.e., normal reaction time to deactivate the warning signals.

Field	4
Missing	0 (horn not activated)
Character	numeric
N/A	0 (see missing)
Value	arabic (M - video tape observation)
Decimals	one
Range	> 0
Units	seconds

36. POSITION

Obvious body/head position during G-LOC as follows:

FORW	forward
BACK	backward
SIDE	sideways
NONE	upright

Field	4
Missing	z
Character	alpha
Value	logical (video tape observation)
N/A	never
Range	see above

37. CNVTMAWK

Convulsing time while awake. Subject already opened his eyes but continues flailing/twitching/convulsing (i.e.. convulsions during RELATIVE {21}) (Figure A18).

Field	3
Missing	99
Character	numeric
N/A	100 ({17} and {18} = 100 and {19} = NO)
Value	arabic (C, video tape observation)
Decimals	none
Range	0 -
Units	seconds

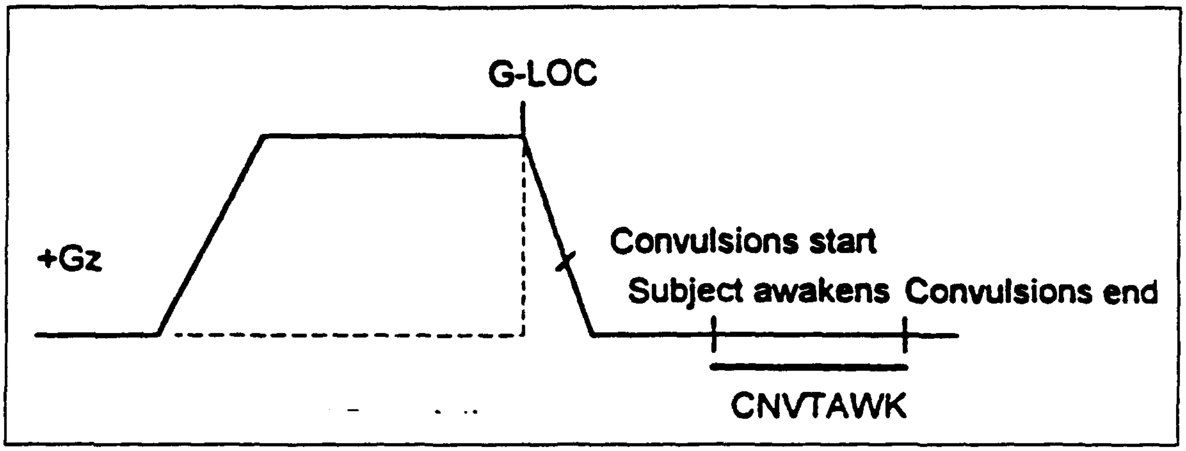


Figure A18. CNVTAWK Description

38. AMNESIA

Does subject recall the exposure/G-LOC?

Field	1
Missing	z (not asked or reported)
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	never (as in most T/F variables)
Range	T/F

39. MOTSICK

Did subject report/experience motion sickness?

Field	1
Missing	z (not asked or reported)
Character	alpha
N/A	never
Range	T/F

40. EUPHORIA

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)". Euphoria. Permutation variable: AIROHPUE. Check: Above applies to variables {40 to 51} where the permutation variable name is the variable name reversed. Data obtained from the G-LOC questionnaires.

0 = rated as 0 (none)
1 = rated as 1 to 5 (low)
2 = rated as 6 to 10 (high)
3 = 11 (non-rated)

Field	2
Missing	z (not asked or reported)
Character	alpha
N/A	z (see missing)
Range	0-11

41. EMBRSMNT

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)". Embarrassment. Pemutation variable: TNMSRBME

Field	2
Missing	z (not asked or reported)
Character	alpha
N/A	z (see missing)
Range	0-11

42. DENIAL

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)". Denial. Permutation variable: LAINED.

Field	2
Missing	z (not asked or reported)
Character	alpha
N/A	Z (see missing)
Range	0-11

43. ANGER

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)". Anger. Permutation variable: REGNA.

Field	2
Missing	z (not asked or reported)
Character	alpha
N/A	Z (see missing)
Range	0-11

44. CONFUSED

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest. 10 highest, 11 for those questionnaires that did not provide for a rating)". Confusion (what happened?). Permutation variable: DESUFNOC

Field	2
Missing	z (not asked or reported)
Character	alpha
N/A	z (see missing)
Range	0-11

45. RELAX

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)": Relaxed. Permutation variable: XALER

Field	2
Missing	z (not asked or reported)
Character	alpha
N/A	z (see missing)
Range	0-11

46. FRIGHT

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)". Fright. Permutation variable: THGIRF

Field 2
Missing z (not asked or reported)
Character alpha
N/A z (see missing)
Range 0-11

47. APATHY

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)": Apathy. Permutation variable: YHTAPA

Field 2
Missing z (not asked or reported)
Character alpha
N/A z (see missing)
Range 0-11

48. FRUSTRAT

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)": Frustration. Permutation variable: TARTSURF

Field 2
Missing z (not asked or reported)
Character alpha
N/A z (see missing)
Range 0-11

49. SADNESS

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)": Sadness. Permutation variable: SSENDAS

Field 2
Missing z (not asked or reported)
Character alpha
N/A z (see missing)
Range 0-11

50. SORPRESA

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)": Surprise. Permutation variable: ASERPROS

Field 2
Missing z (not asked or reported)
Character alpha
N/A z (see missing)
Range 0-11

51. OTHER

Q: "Describe any feelings you may have experienced as you were recovering consciousness (0 lowest, 10 highest, 11 for those questionnaires that did not provide for a rating)": Other. Permutation variable: REHTO

Field	2
Missing	z (not asked or reported)
Character	alpha
N/A	z (see missing)
Range	0-11

52. SURPRISE

Was the subject surprised by his G-LOC?. Q: Were you surprised by your G-LOC or Did you "feel it coming"?

Field	1
Missing	z (not asked or reported)
Character	alpha
N/A	z (see missing)
Range	T/F

53. BLACKOUT

Q: "Did you experience black-out (100% light loss) prior to G-LOC?" (does S/he recall B.O.).

Field	1
Missing	z (not asked or reported in questionnaire)
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	z (see missing)
Range	T/F

54. WHEREAMI

Q: "As you recovered consciousness (you have just opened your eyes), Did you know where you were and why?"

Field	2
Missing	z (not asked or reported)
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	z (see missing)
Range	T/F

55. GUESSUCS

Q: "How long did your period of unconsciousness seem to last?".

S	seconds
M	minutes
H	hours
F	forever

Field 1
Missing z (not asked or reported)
Character alpha
Value logical (G-LOC questionnaire)
N/A z (see missing)
Range see above

56. HORNUCS

Q: "Were you aware of the warning signals during your period of unconsciousness?. i.e., were you able to hear the horn while you were unconscious?.

Field 1
Missing z (not asked or reported)
Character alpha
Value logical (G-LOC questionnaire)
N/A x (signals not activated)
Range T/F

57. HORNOFF

Q: "Did you turn the signals 'off' immediately (as soon as you heard/saw them) upon regaining consciousness?". <Reported as opposed to tape observation>

Field 1
Missing z (not asked or reported)
Character alpha
Value logical (G-LOC questionnaire)
N/A x (warning signals were not activated)
Range T/F

58. HORNWHY

Q: "If answer above is "F", explain why (circle as many as apply)". If HORNOFF {57} is "T", then this question does not apply. If HORNOFF {57} is F, the subjects had a multiple-choice option to answer this question as follows:

A> I was not aware of the signals (light) (horn)
B> I wanted to, but I couldn't get my arm/hand to "move" to do it...
C> I wanted to, but I was flailing/shaking uncontrollably
D> I wanted but I could not remember where the appropriate switch was
E> I forgot what the signals meant/confusion
F> I didn't know what the signals meant
G> I didn't care about the signals, I had other thoughts on my mind
H> Other
I> Combination of the above

Field 1
Missing z (not asked or reported)
Character alpha
Value logical (G-LOC questionnaire)
N/A x (signals not activated)
Range see above

59. SLEEPARY

Q: "Have you ever experienced the feeling of not being able to move even though you were awake before? (i.e., as you wake up from normal sleep, or when you are having a particularly frightening nightmare and you try to wake up but can't"). This Q refers to sleep paralysis.

Field	1
Missing	z (not asked or reported)
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	z (see missing)
Range	T/F

60. FLAILING

Q: "Did you experience any flailing i.e., uncontrollable/ unusual body movements while you were unconscious? (assuming you have not viewed your tape) Note: if you have viewed your tape and exhibited flailing, Do you remember having flailed?". Note: compare with {17-19} may not be the same.

Field	1
Missing	z (not asked or reported)
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	z (see missing)
Range	T/F

61. ERELOC

Q: "Have you experienced G-LOC before?". Check: to agree with {62-63}.

Field	1
Missing	z (not asked or reported)
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	z (see missing)
Range	T/F

62. ERELOCN

Q: "Number of G-LOC incidents". Not including this one. Check: to agree with {61, 63}

Field	3
Missing	99 (not asked or reported)
Character	alpha
N/A	100 (if {61} = F)
Value	arabic (G-LOC questionnaire)
Decimals	none

63. ERELOCWH

Q: Where did previous G-LOC(s) occur.

FUGE	centrifuge
FLITE	inflight
BOTH	both

Field	5
Missing	z (not asked or reported)

Character alpha
Value logical (G-LOC questionnaire)
N/A x ({61} = F and {62} = 100)
Range see above

64. EVENTQUA

Q: "Describe your dream or thoughts as fully as possible" as follows: Quality.

FAM familiar as to surroundings and events
UFAM unfamiliar as to surroundings and events

Field 4
Missing z (not asked or reported)
Character alpha
Value logical (G-LOC questionnaire)
N/A x (sometimes, if {29} = "NONE or "CANT")
Range see above

65. EVENTACT

Q: "Describe your dream or thoughts as fully as possible". This question refers to whether the subject was a passive or active participant in his dream/visions/thoughts as follows: Activity.

ACT active participant
PAS passive

Field 3
Missing z (not asked or reported)
Character alpha
Value logical (G-LOC questionnaire)
N/A x (if {29} = NONE or CANT)
Range see above

66. EVENTINT

Q: "Describe your dream or thoughts as fully as possible". This question refers to the the dream/ visions/ thoughts/whatever intensity as follows: Intensity.

VIV vivid, clear
HAZ hazy, misty

Field 3
Missing z (not asked or reported)
Character alpha
Value logical (G-LOC questionnaire)
N/A x (if {29} = NONE or CANT)
Range see above

67. EVENTELM

Q: "Describe your dream or thoughts as fully as possible". This question refers to the elements of the dream/ visions/ thoughts as follows:

AUD auditory
VIS visual
NONE neither
BOTH both

Field	4
Missing	z (not asked or reported)
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	x(if {29} = NONE or CANT)
Range	see above

68. SLIPDREM

Q: "Would you describe your G-LOC dream comparable to the dreams you would normally experience during sleep?". Check: if EVENT {29} is NONE or CANT this question does not apply.

Field	1
Missing	z (not asked or reported)
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	x (if {29} = NONE or CANT)
Range	T/F

69. DREMRCAL

Q: Do you dream often, (Do you recall your dreams often?).

Field	1
Missing	z (not asked or reported)
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	z (see missing)
Range	T/F

70. AGE

Age of the subject

Field	2
Missing	0
Character	numeric
Value	arabic (data sheet)
N/A	never
Range	> 0
Unit	years

71. WEIGHT

Weight of the subject

Field	3
Missing	0
Character	numeric
Value	arabic (data sheet)
N/A	never
Range	> 0
Unit	pounds

72. HEIGHT

Height of the subject

Field	4
Missing	0
Character	numeric
Value	arabic (data sheet)
Decimals	one
N/A	never
Range	> 0
Units	inches

73. JOB

Subject is member of the:

NAVY	the Navy/Marines
AIR	the Air Force or Air National Guard
OTHER	else

Field	5
Missing	z (not asked or reported)
Character	alpha
Value	logical (data sheet)
N/A	never
Range	see above

74. PPBPBG

Was the subject performing positive pressure breathing (any type of assist).

Field	1
Missing	z
Value	logical (video tape observation)
Character	alpha
N/A	never (as in most T/F)
Range	T/F

75. EVQUAL

Was the EVENT {29}: Quality

P	pleasant
U	unpleasant
I	indifferent

Field	1
Missing	z
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	x (no event)
Range	see above

76. GENDER

Gender of the subject

Field	1
Missing	z
Character	alpha
N/A	never
Range	M/F

77. AEROBIC

Aerobic exercise. Permutation variable: CIBOREA

CIBOREA = 0 when AEROBIC = 0
CIBOREA = 1 when AEROBIC > 0

Field	4
Missing	99.9
Character	numeric
Value	logical (A - data sheet)
Decimals	one
N/A	0 (none)
Units	hrs/week

78. ANAEROBI

Anaerobic exercise. Permutation variable: CIBOREANA

CIBOREANA = 0 when ANAEROBI = 0
CIBOREANA = 1 when ANAEROBI > 0

Field	4
Missing	99.9
Character	numeric
Value	logical (A - data sheet)
Decimals	one
N/A	0 (none)
Units	hrs/week

79. WORK

Type of work as in flying status

FO	flying (pilot/backseater/etc)
NFO	non flying (panel/medeval/etc)

Field	3
Missing	z
Character	alpha
Value	logical (A - data sheet)
N/A	x

80. AIRCRAFT

Type of aircraft flying experience.

Field	3
Missing	z
Character	alpha
Value	logical (A - data sheet)
N/A	x

81. DREMWHR

When during unconsciousness did the dream/thought occur.

B	beginning
M	middle
E	end of unconsciousness period

Field	1
Missing	z
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	x

82. FLALAWAR

Was the subject aware \ Does he recall flailing?

Field	1
Missing	z
Character	alpha
Value	logical (G-LOC questionnaire)
N/A	x
Range	T/F

83. CENTRIFU

Centrifuge where +Gz exposure took place.

Field	4
Missing	z
Character	alpha
N/A	x
Range	USAF ("SAM"); NAVY ("NADC")

APPENDIX B

G-LOC QUESTIONNAIRE

Onset Rate: GOR ROR **Max +Gz:** **FLAILING?** Y N

GLOC Type: Major (obvious body flailing) Minor (minor flailing) Transient (no flailing)

AGLOC ("almost" G-LOC)

AGE: **WEIGHT:** **HEIGHT:** **TOTAL FLT HRS** : **In A/C:**

FLT Status: Pilot Non-Pilot (i.e., back seat) PTO FS CIV Other:

DO NOT WRITE ON THIS LINE **Q#**

The following questionnaire has been developed to better understand the psychologic effects of GLOC and how these affect recovery from the same. Please answer all the questions as *completely* as possible. **THANK YOU FOR YOUR PARTICIPATION!**

1. Describe how you felt as you were recovering consciousness by circling the appropriate number in each of the following (0 being lowest, 10 being highest):

Euphoria	0	1	2	3	4	5	6	7	8	9	10
Anger	0	1	2	3	4	5	6	7	8	9	10
Embarrassment	0	1	2	3	4	5	6	7	8	9	10
Apathy	0	1	2	3	4	5	6	7	8	9	10
Frustration	0	1	2	3	4	5	6	7	8	9	10
Confusion	0	1	2	3	4	5	6	7	8	9	10
Fright	0	1	2	3	4	5	6	7	8	9	10
Sadness	0	1	2	3	4	5	6	7	8	9	10
Surprise	0	1	2	3	4	5	6	7	8	9	10
Relaxation	0	1	2	3	4	5	6	7	8	9	10
Denial	0	1	2	3	4	5	6	7	8	9	10

Other: ______________________________ rating (0-10) __________

2. Were you surprised by your G-LOC or did you "feel it coming"?

SURPRISED NOT SURPRISED

3. Did you experience black-out (100% light loss) prior to G-LOC?

YES NO DO NOT REMEMBER

4. Immediately after recovering consciousness (*YOU HAVE JUST OPENED YOUR EYES*), Did you know where you were [centrifuge] and why [i.e., training]?

YES NO

Please explain:

5. How long did your period of unconsciousness seem to last (estimate)?

SECONDS MINUTES HOURS FOREVER

6. Were you aware of the warning signals (light and horn) *DURING* your period of unconsciousness? (i.e. were you able to hear the horn while you were unconscious?)

YES NO

Return to ______________________ or: EM FORSTER *ACME Labs* NAWC Code 6023 Warminster, PA 18974, (215) 441-1490

7. Did you turn these signals "off" *IMMEDIATELY, within 5 seconds* (as soon as you heard/saw them) upon regaining consciousness?

YES NO

IF ANSWER IS "NO", EXPLAIN WHY (CIRCLE AS MANY AS APPLY):

a) I was not aware of the signals: light? horn? both?
b) I wanted to, but I couldn't get my arm/hand to "move" to do it.
c) I wanted to, but I was flailing/shaking uncontrollably.
d) I wanted to, but I did not know where the appropriate switch was:
   i) was not told where it was
   ii) forgot where it was
e) I forgot what the signals meant.
f) I didn't know what the signals meant. was not told what the signals meant.
g) I didn't care about the signals, I had other thoughts on my mind at the time.
h) Other: ______________________

8. Have you ever experienced the feeling of not being able to "move" even though you were awake before? (i.e., as you wake up from normal sleep, or when you are having a particularly frightening nightmare and you try to wake up but "can't").

YES NO

9. Did you experience any flailing/convulsions i.e., uncontrollable/unusual body movements while you were unconscious? (assuming you have not viewed your tape) Note: If you have viewed your tape and exhibited flailing, Do you remember having flailed?

YES NO *Have you viewed your videotape?* YES NO

10. Have you experienced GLOC before?

YES NO

IF ANSWER IS "YES" PLEASE SPECIFY:

Number of GLOC incidents:

Where these incidents occurred (circle as applies): CENTRIFUGE# ____ INFLIGHT# ____ OTHER# ____

11. Other than G-LOC, have you fallen unconscious before? (i.e., fainting, surgical anaesthesia). If so, would you describe that experience comparable to your G-LOC experience?, HOW DO THEY DIFFER?, HOW ARE THEY SIMILAR?

____

____

____

12. Did you experience any dreams (i.e. visual imageries) or thoughts while you were unconscious?

DREAM THOUGHT NO OTHER: ____________________

IF YOU ANSWERED "NO" GO TO QUESTION 16

13. Describe your dream or thoughts as fully as possible. To facilitate this description, PLEASE CIRCLE ONE ANSWER IN *EACH* OF THE FOLLOWING CATEGORIES:

EVENTS	familiar	unfamiliar	
SETTING	familiar	unfamiliar	
I WAS AN/A	active participant	spectator	
INTENSITY	vivid/clear/good recall	hazy/misty	
QUALITY	pleasant/unpleasant	indifferent	other: ________
ELEMENTS	auditory (i.e. music, talk)	visual (images)	both

Describe your dream or thoughts:

____

____

____

14. Estimate when during your period of unconsciousness did the dream/thoughts occurred:

BEGINNING MIDDLE END (of unconsciousness period)

15. Would you describe your GLOC-dream comparable to the dreams you would normally experience during sleep?

YES NO

WHY? (HOW ARE THEY THE SAME/DIFFERENT)

____

____

____

16. Do you recall your dreams often?

YES NO

Any other comments about your GLOC experience?
Do you find it valuable as a "training tool"? HOW?

____

____

____

DATA ENTRY SHEET

ENTRY VARIABLE	#	MISS/NA	RANGE											
PUNTO	1	never	1-											
AGTIP	2	z/never	1-											
			GTIP											
			AILSS											
			PRO											
			FUNK											
			ACES											
			DCIM											
			TLSS											
			PALE											
			MEDEV											
			RES											
			LGLOC											
			WGLOC											
			FLITE											
STUDY	3	z/never												
DATE	4	0/never	MO.YR											
LOCTAPE	5	z	1-											
TAPECT	6	never/10000	MIN.SEC											
BASEG	7	0/never	1-											
MAXG	8	0/never	1-											
GOFLOC	9	0/never	1-											
WHENLOC	10	z/never	P U D B											
RELTOL	11	0/never	1-											
TIMAX	12	0/never	>0											
TIMG	13	0/never	>0											
LOCINDTI	14	0/never	>0											
TIMEND	15	0/never	>0											
TMAX	16	0/100	>0											
CONINDTI	17	99/100	POS NEG											
CONVTIM	18	0/100	>0											

DATA ENTRY SHEET

CONVTYP	19	miss/no	MAJ MED MIN											
ABSOLUTE	20	0/never	>0											
RELATIVE	21	0/never	>0											
TOTAL	22	0/never	>0											
GSUIT	23	z/never	T/F											
SEAT	24	0/never	>0											
STRAIN	25	z/never	T/F											
PLL	26	99/never	0-90											
BREATHE	27	z/never	T/F											
PIGTIME	28	0/100	>0											
			NONE											
			DREM											
			THOT											
EVENT	29	z/never	CANT											
			GLOC											
			LOCO											
LOCTYP	30	z/neve	TRANSr											
			GOR ROR											
PROFILE	31	z/never	RORX											
DREAMQ	32	never/0	>0											
JOESUIT	33	z/never	T/F											
TOYINCAP	34	0	>0											
TOYINCER	35	0	>0											
			FORW											
			BACK											
			BOTH											
			NONE											
POSITION	36	Z/never	SIDE											
CNVTMAWK	37	99/100	0-											
AMNESIA	38	z/never	T/F											
MOTSICK	39	z/never	T/F											
EUPHORIA	40	Z	0-11											
EMBRSMNT	41	Z	0-11											

DATA ENTRY SHEET

DENIAL	42	Z	0-11											
ANGER	43	Z	0-11											
CONFUSED	44	Z	0-11											
RELAX	45	Z	0-11											
FRIGHT	46	Z	0-11											
APATHY	47	Z	0-11											
FRUSTRAT	48	Z	0-11											
SADNESS	49	Z	0-11											
SORPRESA	50	Z	0-11											
OTHER	51	Z	0-11											
SURPRISE	52	Z	T/F											
BLACKOUT	53	Z	T/F											
WHEREAMI	54	Z	T/F											
GUESSUCS	55	Z	S F M H											
HORNUCS	56	Z/X	T/F											
HORNOFF	57	Z/X	T/F											
HORNWHY	58	Z/X	A-I											
SLEEPARY	59	Z	T/F											
FLAILING	60	Z	T/F											
ERELOC	61	Z	T/F											
ERELOCN	62	99/100	>0											
			FUGE											
			FLITE											
ERELOCWH	63	Z/X	BOTH											
			FAM											
EVENTQUA	64	Z/X	UFAM											
EVENTACT	65	Z/X	ACT PAS											
EVENTINT	66	Z/X	VIV HAZ											
			AUD VIS											
			BOTH											
EVENTELM	67	Z/X	NONE											
SLIPDREM	68	Z/X	T/F											
DREMRCAL	69	Z	T/F											

DATA ENTRY SHEET

AGE	70	0/never	>0											
WEIGHT	71	0/never	>0											
HEIGHT	72	0/never	>0											
			NAVY AIR											
JOB	73	z/never	OTHER											
PPBPBG	74	z/never	T/F											
EVQUAL	75	z/x	P U I											
GENDER	76	z/never	M/F											
AEROBIC	77	99/0	>0											
ANAEROBI	78	99/0	>0											
WORK	79	z/x	FO/NFO											
AIRCRAFT	80	z/x	vary											
DRMWHR	81	z/x	B M E											
FLALAWAR	82	z/x	T/F											
			SAM											
			NADC											
CENTRIFU	83	z/x	OTHER											

NAWCADWAR
CENTRIFUGE TRAINING RUN SHEET

DATE:
GTIP #:
PROJECT:

LAST NAME:		**FIRST NAME:**	**RANK:**
HEIGHT:	**WEIGHT:**	**AGE:**	**SSN:**

FLT stat: Pilot/Backseat/FS/CIV/Other:		**Squadron:**	**Current A/C:**
FLT hrs in current A/C:	**Total FLT hrs:**	**Tactical FLT hrs:**	**Hrs last 30 days:**

CONDITIONING PROGRAM

AEROBIC		**STRENGTH**		**NECK**	
TYPE	*Hrs/week*	*TYPE*	*Hrs/week*	*TYPE*	*Hrs/week*
Jog/Run/Walk		Nautilius		Nautilius	
Swim		Free Weights		Free weights	
Row		Isometrics		Isometrics	
Aerobics		Other:		Other:	
Other:					

G TOLERANCE FACTORS

Hrs of sleep last 24 hrs:	Smoking tobacco: pks/day	Years of use:
Usual hrs of sleep:	Chewing tobacco: cans/day	
Alcohol intake last 24 hrs (note: glass, oz, cans?):		Time of last drink (0000-2400 hrs):
Type (beer, wine, liquor):		
Recent illnes (last 7 days)? YES NO	Type of illness:	
Are you currently taking any medications: YES NO If yes, What: When:		

Are you presently in a DOWN STATUS for any reason? If YES, explain WHY:
COACH: ***RECORDER:***

NAME	Time in:	Time out:	GLOC Q#:	GTIP #:

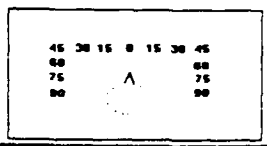
Run Type (GOR, ROR, RORX)	Run Number	Pre-run Heart Rate	Anti-G suit (y/n)	Relaxed Tolerance ("now")	Max Straining Tolerance (AGSM)	AGSM Improvement	Run Duration (sec)	Max Heart Rate	PLL (degrees off the nose) PLEASE specify if reported as % or degrees from the periphery)	Reason for Run Termination (SEE CODE)

ANTHROPOMETRIC MEASUREMENTS

MEASURE	*INCHES*	*CODE*
SHOULDER WIDTH		
TRUNK HEIGHT		
SITTING HEIGHT		
FUNCTIONAL REACH		
BKL		
BLL		

RUN TERMINATION CODES

EOR	End or run, normal termination.
LOC	Loss of Consciousness (regardless of who stopped the run)
CS	Error of any type (computer error, PS by mistake...)
PLL	Peripheral light loss, 30 deg. off the nose (60 deg.-old way)
	Make sure subject knows what you mean by degrees of loss
FAT	Fatigue, subject tired
PAIN	Pain (specify WHERE)
1EYE	1 eye light loss (specify WHICH)
OTHE	Specify WHAT



COMMENTS (specify run #)

APPENDIX C

RESULTS

VARIABLE 1: PUNTO

Total of 243 distinct subjects (encompassing 354 G-LOC exposures)

VARIABLE 2: AGTIP

All subject entries have a GTIP i.d. (if applicable). The maximum number of study runs per subject is 4.

VARIABLE 3: STUDY

Frequency:

STUDY	N
GTIP	279
AILSS	7
PROF	9
FUNK	15
SPOOL	0
ACES	13
DCEIM	3
TLSS	1
PALE	1
MEDEV	0
RES	8
WGLOC	6
LGLOC	9
FLITE	2
	1
T	354

VARIABLE 4: DATE

Dates range from 12/1985 to 3/1992

VARIABLE 5: LOCTAPE

Encompasses information from 8 master G-LOC videotapes (*I* through *VIII*)

VARIABLE 6: TAPECT

All videotapes are in 3/4" VHS format, 1 hour duration each.

VARIABLE 7: BASEG {+Gz}

GTIP exposures: 1.2 ± 0.1 (230) [1 to 1.3]

1 to 1.2 +Gz is the normal base +Gz level for most +Gz exposures at NAWC

VARIABLE 8: MAXG/GMAX/GXAM {+Gz}

Figures C1-C3
Frequency:

GXAM

TYPE	N	%	%
.	6	2	-
5	13	5	5
6	31	11	11
7	36	13	13
8	82	29	30
9	111	40	41
T	279	100	100

GMAX

TYPE	N	%
7	66	24
9	213	76
T	279	100

MAXG =	7.91 ± 1.22 (273)	N Total=	279 [5 to 9.3]
GXAM=	7.90 ± 1.19 (273)	N Total=	279
MAXG GOR=	7.00 ± 1.15 (81)	N Total=	83
MAXG ROR=	8.29 ± 1.03 (192)	N Total=	193
GXAM GOR=	7.00 ± 1.15 (81)	N Total=	83
GXAM ROR=	8.28 ± 0.98 (192)	N Total=	193
=			3
T			279

TABLE 1. The Effect of GXAM on Incapacitation Times (mean ± S.D. (N))

	GXAM				
VARIABLE	5	6	7	8	9
CONINDTI	5.2 ± 3.4 (6)	2.3 ± 3.4 (19)	3.7 ± 3.0 (23)	2.9 ± 2.3 (53)	3.7 ± 1.9 (75)
CONVTIM	3.4 ± 1.8 (8)	5.4 ± 2.9 (16)	4.1 ± 2.0 (23)	4.7 ± 2.4 (50)	4.3 ± 2.3 (70)
ABSOLUTE	9.1 ± 3.7 (7)	6.2 ± 3.8 (19)	7.5 ± 5.0 (22)	6.9 ± 3.7 (55)	6.9 ± 3.2 (74)
RELATIVE	7.3 ± 3.3 (7)	8.3 ± 4.0 (19)	9.5 ± 3.8 (22)	8.5 ± 3.9 (51)	8.9 ± 4.8 (71)
TOTAL	13.8 ± 6.1 (9)	13.2 ± 6.7 (24)	14.2 ± 7.4 (32)	15.1 ± 4.9 (61)	14.7 ± 6.0 (86)
TOYINCAP	12.4 ± 6.4 (8)	13.6 ± 7.6 (26)	15.6 ± 10.5 (28)	13.9 ± 5.1 (64)	14.1 ± 6.8 (80)
CNVTMAWK	2.8 ± 2.4 (4)	3.4 ± 1.8 (12)	2.7 ± 1.6 (15)	2.9 ± 2.3 (33)	2.8 ± 1.8 (40)
TRUETOT	7.7 ± 6.6 (4)	9.7 ± 6.6 (11)	13.9 ± 11.8 (21)	11.9 ± 4.7 (25)	10.2 ± 2.7 (15)

TABLE 2. The Effect of PROFILE and GXAM on Incapacitation Times (mean ± S D (N))

		PROFILE		
VARIABLE	GXAM	GOR	ROR	P
LOCINDTI				
	5	38.8 ± 1.6 (5)	(0)	
	6	49.7 ± 6.2 (6)	10.1 ± 4.1 (13)	
	7	60.2 ± 6.1 (16)	7.8 ± 1.5 (12)	
	8	72.0 ± 6.8 (10)	8.9 ± 1.5 (12)	
	9	76.6 ± 10.2 (5)	8.8 ± 2.4 (75)	
CONINDTI				
	5	5.2 ± 3.4 (6)	(0)	
	6	4.6 ± 3.6 (7)	1.0 ± 2.5 (12)	.019
	7	4.0 ± 3.4 (12)	3.4 ± 2.5 (11)	
	8	3.9 ± 2.4 (16)	2.5 ± 2.1 (37)	.037
	9	5.7 ± 3.2 (6)	3.5 ± 1.7 (69)	.006
CONVTIM				
	5	3.4 ± 1.9 (7)	(1)	
	6	5.5 ± 2.7 (6)	5.3 ± 3.2 (10)	
	7	4.8 ± 2.3 (12)	3.4 ± 1.4 (11)	
	8	5.6 ± 3.3 (15)	4.3 ± 1.8 (35)	
	9	6.5 ± 5.8 (4)	4.2 ± 1.9 (66)	
ABSOLUTE				
	5	9.1 ± 3.7 (7)	(0)	
	6	8.9 ± 4.3 (7)	4.6 ± 2.6 (12)	.014
	7	8.4 ± 5.8 (14)	6.0 ± 2.8 (8)	
	8	10.3 ± 3.3 (19)	5.2 ± 2.6 (36)	.000
	9	14.0 ± 5.9 (5)	6.4 ± 2.2 (69)	.04
RELATIVE				
	5	7.3 ± 3.3 (7)	(0)	
	6	10.4 ± 3.6 (7)	7.0 ± 3.9 (12)	
	7	9.9 ± 3.9 (14)	8.8 ± 3.7 (8)	
	8	8.5 ± 3.7 (17)	8.6 ± 4.1 (34)	
	9	8.8 ± 3.6 (5)	8.9 ± 4.9 (66)	
TOTAL				
	5	13.8 ± 6.1 (9)	(0)	
	6	18.4 ± 6.8 (8)	10.6 ± 5.1 (16)	.004
	7	14.6 ± 8.6 (20)	13.5 ± 5.2 (12)	
	8	18.3 ± 4.6 (19)	13.6 ± 4.5 (42)	.000
	9	21.0 ± 4.9 (6)	14.2 ± 5.8 (80)	.006
CNVTMAWK				
	5	2.7 ± 2.9 (3)	(1)	
	6	2.0 ± 1.7 (3)	3.9 ± 1.7 (9)	
	7	3.1 ± 1.9 (8)	2.1 ± 1.1 (7)	
	8	3.8 ± 4.7 (6)	2.7 ± 1.4 (27)	
	9	2.0 ± 1.4 (2)	1.9 ± 1.9 (38)	
N TOTAL	5	12	1	
	6	13	18	
	7	24	12	
	8	25	57	
	9	7	104	

ABSOLUTE= PROFILE GXAM PROFILE*GXAM	F= 22.5	p= .000	R^2= .28
PROFILE	F= 57.3	p= .000	
GXAM	F= 9.7	p= .002	
PROFILE*GXAM	F= 0.5	p= .466	
Duncan, alpha= .05 GOR= 9.8 s	ROR= 5.8 s		

TOTAL= PROFILE GXAM PROFILE*GXAM	F= 7.5	p= .000	R^2= .09
PROFILE	F= 12.8	p= .000	
GXAM	F= 9.4	p= .002	
PROFILE*GXAM	F= 0.3	p= .618	
Duncan, alpha= .05 GOR= 16.7 s ROR= 13.6 s			

LOCINDTI= MAXG (GOR exposures) F= 139.6p= .000 R^2= .77

LOCINDTI= -12.2 + 10.3 * MAXG

Intercept t= -1.95 p= .05
Parameter t= 11.81 p= .000

LOCINDTI relationship with MAXG is expected when the GOR exposures were considered. Predicting incapacitation times given the profile and maximum +Gz level was attempted but the resulting reliability of the results was very low if significant.

VARIABLE 9: GOFLOC {+Gz}

GTIP exposures: 7.7 ± 1.6 (271) [1 to 9.3]

The +Gz level when G-LOC occurs agrees with WHENLOC {10} below where most G-LOC episodes ocurred during plateau at the peak +Gz level. It also agrees with PROFILE {31} where all ROR X exposures have a plateau at peak +Gz level.

VARIABLE 10: WHENLOC

Figure C4
Frequency:

TYPE	N	%	%
.	3	1	-
P	179	64	65
U	78	28	28
D	18	6	6
B	1	1	1
T	279	100	100

During the ROR exposures, G-LOC mostly occurred at plateau as confirmed by GOFLOC above and PROFILE {31}.

VARIABLE 11: RELTOL {+Gz}

GTIP exposures: 4.6 ± 0.8 (262) [2.5 to 8]

This figure has been previously reported in the literature. However, it is specially valuable since it describes pilots . It also confirms that non-aircrew centrifuge subjects are comparable to the pilot population when RELTOL is a concern.

VARIABLE 12: TIMAX {s}

GTIP exposures: 16.3 ± 24.3 (185) [2 to 87]

Time to maximum +Gz level includes both GOR and ROR/X exposures hence, the large standard deviation.

VARIABLE 13: TIMG {s}

GTIP exposures: 25.4 ± 21.8 (178) [1 to 99]

Total time at +Gz includes both GOR and ROR/X exposures hence, the large standard deviation.

VARIABLE 14: LOCINDTI {s}

GTIP exposures: 20.8 ± 23.0 (182) [5 to 86]

G-LOC induction time includes both GOR and ROR/X exposures hence, the large standard deviation

VARIABLE 15: TIMEND {s}

GTIP exposures: 5.6 ± 3.5 (223) [1 to 30]

This variable, time from peak +Gz to base +Gz, was difficult to obtain because of the shape of the deceleration curve where the rate of descent was faster in the initial portion of deceleration. Hence, the large standard deviation. This variable would be more reliable if the slope of the descent is obtained as opposed to obtaining the variable from videotape observation. However, the +Gz profile trace (a haversine) was unavailable. Please refer to reference 30 for a discussion on the effect of offset rate on incapacitation variables.

VARIABLE 16: TMAX {s}

GTIP exposures (ROR): 5.4 ± 2.2 (183) [1 to 16]

Recall that this variable, time at maximum +Gz (i.e., at plateau) refers only to ROR/X exposures.

VARIABLE 17: CONINDTI {s}

GTIP exposures: 3.3 ± 2.5 (176) [4 to 12]

Time to convulsive behavior from G-LOC onset is comparable to the one reported in the literature (31).

VARIABLE 18: CONVTIM {s}

GTIP exposures: 4.5 ± 2.4 (167) [1 to 13]

Duration of convulsions is comparable to the one reported in the literature (31).

VARIABLE 19: CONVTYP

Figures C5 - C6
Frequency:

TYPE	N	%	%
.	52	19	-
NO	30	11	13
MIN	83	30	37
MED	46	16	20
MAJ	68	24	30
T	279	100	100

TABLE 3. The effect of CONVTYP on incapaciation variables.

	CONVTYP							
	MIN		MED		MAJ		NO	
VARIABLE	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
MAXG	7.8	1.3	7.8	1.1	8.1	1.2	7.9	1.1
RELTOL	4.6	0.9	4.6	0.8	4.6	0.9	4.5	0.9
TIMG	20.3	16.2	25.7	22.8	28.1	22.6	32.4	28.0
TMAX	5.3	2.6	4.9	2.0	5.5	1.7	5.7	2.6
CONINDTI	2.6	2.5	3.3	2.7	3.9	2.2		
CONVTIM	3.8	2.1	4.1	2.1	5.4	2.5		
ABSOLUTE	5.5	2.9	6.6	3.4	8.6	3.9	5.9	3.4
RELATIVE	7.5	3.4	10.3	6.0	9.1	3.8	7.5	2.9
TOTAL	12.1	4.8	15.0	7.4	17.5	5.1	11.2	5.0
PIGTIME	2.8	1.4	3.8	2.3	3.5	2.5	3.7	0.6
TOYINCAP	11.2	4.6	16.4	10.2	15.8	5.0	11.7	4.4
TOYINCER	1.7	0.9	1.5	0.5	1.6	0.8	1.8	0.6
CNVTMAWK	3.1	1.7	3.5	2.5	2.3	1.6		
AGE	32.1	7.1	30.0	6.2	31.3	6.7	33.2	8.8
WEIGHT	178	20.2	179	17.8	179.2	172	172	21.5
HEIGHT	71.4	2.6	71.4	2.3	71.5	2.9	71.6	2.8
AEROBIC	3.3	2.1	3.2	2.0	3.3	2.2	2.4	2.3
ANAEROBI	3.5	2.7	3.0	1.1	3.8	2.3	1.6	1.9

ABSOLUTE: Duncan, p=.05 MAJ > MED, MIN, NO
TOTAL: Duncan, p=.05 MAJ, MED > MIN, NO

Eighty-seven percent of the G-LOC exposures exhibited convulsive behavior where the incapacitation time tended to be longer for those subjects who exhibited major convulsive movements. Minor convulsions, usually mimic (face twitches) were more typical of "LOCO" G-LOC type (LOCTYP {30}).

VARIABLE 20: ABSOLUTE {s}

GTIP exposures: 7.2 ± 4.9 (179) [1 to 50]

VARIABLE 21: RELATIVE {s}

GTIP exposures: 8.8 ± 4.3 (170) [1 to 38]

VARIABLE 22: TOTAL (s)

GTIP exposures: 14.5 ± 6.0 (212) [2 to 47]

The variables absolute, relative, and total incapacitation are comparable to those published in the literature.

VARIABLE 23: GSUIT

Figure C7
Frequency:

TYPE	N	%	%
.	15	5	-
F	75	27	28
T	189	68	72
T	279	100	100

As a rule, all GOR exposures do not have an activated G--suit, all RORX exposures do. Hence the similarity to PROFILE (31) percentages.

VARIABLE 24: SEAT

Figure C8
Frequency:

TYPE	N	%	%
.	20	7	-
15	120	43	46
30	139	50	54
T	279	100	100

VARIABLE 25: STRAIN

Frequency:

TYPE	N	%
.	15	5
F	0	0
T	264	95
T	279	100

All GTIP exposures require straining sometime during the exposure.

VARIABLE 26: PLL (degrees)

GTIP exposures: (206) [0 to 90]

Peripheral light loss ranged from 0 to 90 degrees. The main difficulty with this variable is that the subjects occasionally report percentage of light loss instead. Also, degrees of loss were discrete values, hence, a mean is not given.

VARIABLE 27: BREATHE

Figures C9 - C10
Frequency:

TYPE	N	%	%
.	61	22	-
F	149	53	68
T	69	25	32
T	279	100	100

TABLE 4. Incapacitation Variables as Related to the Occurrence of BREATHE.

	BREATHE						
	F			T			
VARIABLE	mean	s.d.	n	mean	s.d.	n	p
LOCINDTI	19.2	20.2	109	19.8	22.6	54	
CONINDTI	2.9	2.4	101	3.7	2.1	61	
CONVTIM	4.3	1.9	99	5.0	3.0	57	
ABSOLUTE	6.1	3.4	96	7.8	3.4	63	.002
RELATIVE	8.9	4.9	91	8.2	3.4	61	
TOTAL	13.4	6.3	127	15.5	4.9	67	.010
PIGTIME	0			3.3	2.1	58	
TOYINCAP	13.5	7.6	122	14.4	5.0	59	
TOYINCER	1.6	0.6	55	1.7	0.9	21	
CNVTMAWK	3.2	1.7	66	2.3	2.3	34	
AGE	31.0	6.8	148	32.6	7.2	67	
WEIGHT	175.5	18.5	147	182.4	20.4	67	
HEIGHT	71.3	2.2	147	71.8	2.5	66	

Thirty-two percent of the subjects exhibited obvious breathing symptoms and these were associated with a longer incapacitation time.

VARIABLE 28: PIGTIME (s)

GTIP exposures: 3.3 ± 2.1 (58) [1 to 13]

The time from G-LOC to breathing symptom onset is shorter than CONVTIM where the breathing symptoms usually occurred immediately prior to convulsions.

VARIABLE 29: EVENT/EVENTO

Figures C11 - C12
Frequency:

EVENT

TYPE	N	%	%
.	44	16	-
DREM	76	27	32
NONE	133	48	57
THOT	26	9	11
T	279	100	100

EVENTO

TYPE		N	%	%
.		44	16	-
ILLU	102	37	43	
NOILLU		133	47	57
T		279	100	100

TABLE 5. Incapacitation Variables as Related to the Occurrence of EVENT (mean ± S.D.)

	EVENTO		
VARIABLE	**ILLU**	**NOILLU**	**p**
LOCINDTI	23.4 ± 25.9	20.7 ± 21.9	
CONINDTI	3.8 ± 2.6	2.7 ± 2.2	.007
CONVTIM	4.8 ± 2.6	4.4 ± .3	
CNVTMAWK	2.9 ± 2.5	2.8 ± 1.6	
ABSOLUTE	8.2 ± 5.9	5.8 ± 3.5	.002
RELATIVE	9.1 ± 4.7	8.5 ± 3.9	
TOTAL	16.4 ± 6.2	12.8 ± 5.6	.000
PIGTIME	3.4 ± 1.6	3.5 ± 2.8	
TOYINCAP	15.7 ± 6.9	13.0 ± 7.3	.012
TOYINCER	1.7 ± 1.3	1.6 ± 0.7	

VARIABLE 30: LOCTYP

Figures C13 - C14

Frequency:

TYPE	N	%	%
.	12	4	-
GLOC	196	70	73
TRANS	50	18	19
LOCO	21	8	8
T	279	100	100

TABLE 6. Incapacitation Variables as Related to LOCTYP

VARIABLE		**GLOC**			**TRANS**			**LOCO**	
	mean	**s.d.**	**n**	**mean**	**s.d.**	**n**	**mean**	**s.d.**	**n**
MAXG	8.0	1.2	192	7.8	1.3	50	7.9	1.4	21
RELTOL	4.6	0.8	183	4.7	0.9	49	4.4	0.7	21
LOCINDTI	20.9	23.8	136	20.7	20.5	35	20.8	22.1	11
CONINDTI	3.8	2.4	143	1.4	1.6	27	0.2	0.5	5
CONVTIM	4.3	2.4	131	5.2	2.2	28	4.0	1.8	7
ABSOLUTE	7.6	4.9	163	3.3	3.0	15			0
RELATIVE	8.7	4.3	156	9.2	3.8	13			0
TOTAL	15.9	5.6	162	10.3	5.2	41	8.8	6.3	8
PIGTIME	3.3	2.1	56	4.0	1.4	2			0
TOYINCAP	14.9	6.3	157	11.6	9.5	37	9.9	5.1	8
TOYINCER	1.6	0.8	51	1.7	0.7	24	1.6	0.4	6
CNVTMAWK	2.2	1.4	73	4.5	2.4	24	4.0	1.8	7
AGE	31.1	6.7	192	31.8	8.0	9	34.0	9.1	21
WEIGHT	178.5	18.9	180	176.2	18.7	49	174.1	15.9	20
HEIGHT	71.7	2.6	179	70.8	2.4	49	71.4	2.6	20
AEROBIC	3.4	2.0	137	3.3	2.3	37	2.4	1.6	15
ANAEROBI	3.6	2.4	88	2.8	1.4	26	2.8	1.4	10

TOTAL = LOCTYP: $F = 21.05$ $p = .0001$ $R^2 = .17$

Duncan & Tukey 'GLOC' > 'TRANS', 'LOCO'

The majority (73%) of the exposures resulted in "classic", easily recognizable G-LOC episodes where a longer incapacitation time was associated with this type of G-LOC as expected.

VARIABLE 31: PROFILE

Figures C15 - C17
Frequency:

TYPE	N	%	%
.	3	1	-
GOR	83	30	30
ROR	169		
RORX	24	69	70
T	279	100	100

TABLE 7. Effect of PROFILE on Incapacitation Times

VARIABLE	GOR mean	GOR s.d.	GOR n	ROR mean	ROR s.d.	ROR n	p
BASEG	1.0	0.1	61	1.2	0 0	169	
MAXG	7.0	1.2	81	8 3	1.0	192	
RELTOL	4.7	0.7	76	4 6	0.9	186	
TIMAX	59.6	12.7	42	3.6	1 1	143	
TIMG	63.9	13.8	39	14 6	4 8	139	
TIMEND	5.3	3.0	63	5 7	3 6	160	
TMAX			0	5 4	2 2	183	
LOCINDTI	60 9	13.3	42	8.8	2.3	140	
CONINDTI	4.4	3.0	47	3.0	2.1	129	.004
CONVTIM	5.1	3.1	44	4.2	2.0	123	
ABSOLUTE	9.7	4.6	53	6.2	4 6	126	.000
RELATIVE	9.0	3.7	50	8.7	4.5	120	
TOTAL	16.7	6.9	62	13.6	5.4	150	.002
PIGTIME	4.4	2.7	14	3.0	1.7	44	
TOYINCAP	16.9	8.5	58	13.0	6 1	148	.002
TOYINCERE	1.6	0.7	23	1.6	0 8	59	
CNVTMAWK	3.0	2.9	22	2.9	1.7	82	
AGE	31.5	7.3	81	31.5	7.1	189	
WEIGHT	172.6	15.8	74	179.4	19.5	184	
HEIGHT	71.1	2.9	74	71.6	2.5	183	
AEROBIC	3.7	.2	57	3.0	1.9	138	
ANAEROBI	3.7	2.7	43	3.2	2.0	86	

TOTAL = PROFILE: F= 12.4 p= .0005 R^2= .06

ABSOLUTE = PROFILE JOESUIT: F= 19.4 p= .0001 R^2= .21
PROFILE: F= 32.9 p= .0001
JOESUIT: F= 5.9 p= .015

ABSOLUTE vs CONINDTI: GOR: r= .59 F= 21.6 p= .0001
ABSOLUTE= 5 8 + .91 * CONINDTI

Intercept:	t= 5.3	p= .0001	
Parameter:	t= 4.7	p= .0001	R^2= .35

ROR: r= .57 F= 50.3 p= .0001
ABSOLUTE= 3.9 + .67 * CONINDTI

Intercept:	t= 10.6	p= .0001	
Parameter:	t= 7.1	p= .0001	R^2= .32

As reported in the literature (31), GOR exposures are associated with a longer incapacitation time Note, the longer the absolute incapacitation is, the longer for convulsions to begin - probably confirming the theory that the convulsions are a signal of return of blood flow to the CNS.

VARIABLE 32: DREAMQ

All questionnaires were enumerated (< 260)

VARIABLE 33: JOESUIT

Figures C18 - C19
Frequency:

TYPE	N	%	%
.	31	11	-
F	141	51	57
T	107	38	43
T	279	100	100

TABLE 8. Effect of JOESUIT on Incapacutation Times (mean ± S.D (N))

	JOESUIT		
VARIABLE	F	T	p
LOCINDTI	21 4 ± 24 (82)	20.5 ± 22 (99)	
CONINDTI	3.7 ± 2.7 (93)	2.9 ± 2.2 (82)	
CONVTIM	4.6 ± 2.7 (90)	4.3 ± 1.9 (76)	
CNVTMAWK	3.2 ± 2.3 (47)	2.6 ± 1.6 (57)	
ABSOLUTE	8.3 ± 5.9 (99)	5.8 ± 2.7 (79)	.000
RELATIVE	8.4 ± 3.8 (90)	9.2 ± 4.7 (79)	
TOTAL	15.2 ± 6.0 (107)	13.8 ± 6.0 (104)	

ABSOLUTE = PROFILE JOESUIT:	F= 19.4	p= .0001	R^2= .21
PROFILE:	F= 32.9	p= .0001	
JOESUIT:	F= 5.9	p= .015	

There was a relationship with JOESUIT where a shorter ABSOLUTE was evident for those subjects whose suit was inflated upon G-LOC (10).

VARIABLE 34: TOYINCAP {s}

GTIP exposures: 14.1 ± 7.0 (206) [.5 to 16.2]

The computerized measurement of total incapacitation was similar to the one measured from videotaped observation (TOTAL {22}) of 14.5 ± 6.0

VARIABLE 35: TOYINCER {s}

GTIP exposures: 1.6 ± 0.8 (82) [0.1 to 4.4]

If the normal reaction time to deactivate the warning signals is substracted from TOYINCAP, the resulting value is the "true total incapacitation" (as measured by this method) of 12.5 s.

VARIABLE 36: POSITION

Figure C20
Frequency:

TYPE	N	%	%
.	49	18	-
FORW	101	36	44
BACK	11	4	5
NONE	91	32	40
SIDE	27	10	11
T	279	100	100

Most subjects either leaned forward (loss of muscle tone) during unconsciousness or remained upright. This calls to attention the suggestion made by some researchers in implementing a "head-hold" to prevent potential neck injury (G-LOC panel, Annual Meeting of the Aerospace Medical Association, 1990)

VARIABLE 37: CNVTMAWK {s}

GTIP exposures: 2.9 ± 2.0 (104) [1 to 13]

Recall that this variable includes "silent" moments between convulsions, hence, the high standard deviation. The value is comparable to the one found in the literature (4 s).

VARIABLE 38: AMNESIA

Figure C21
Frequency:

TYPE	N	%	%
.	157	56	-
F	87	31	71
T	35	13	29
T	279	100	100

As evident from the results above, most subjects recall the events that led to their G-LOC episode. However those that did not, usually did not even recall the exposure having taken place.

VARIABLE 39: MOTSICK

Figure C22
Frequency:

TYPE	N	%	%
.	225	81	-
F	24	8	44
T	30	11	56
T	279	100	100

This variable was usually reported by the subject (not asked), hence, the amount of missing data.

VARIABLE 40: EUPHORIA/AIROHPUE

Figure C23

TYPE (EUPHORIA)	.	0	1	2	3	4	5	6	7	8	9	10	11
N	69	129	3	1	5	1	3	2	10	13	4	7	32

TYPE (AIROHPUE)	0	1	2	3
N	129	13	36	32
%	62	6	17	15

Thirty-eight percent of the exposures resulted in euphoria, it was usually related to pleasant dreams.

VARIABLE 41: EMBRSMNT/TNMSRBME

Figure C23

TYPE (EMBRSMNT)	.	0	1	2	3	4	5	6	7	8	9	10	11
N	69	127	5	2	7	4	10	5	9	3	0	7	31

TYPE (TNMSRBME)	0	1	2	3
N	127	28	24	31
%	61	13	11	15

Thirty-nine percent of the exposures resulted in the subject being embarrassed. This variable was probably underestimated since videotape observation invariably showed most subjects being embarrassed about their G-LOC episode. Given the personality of pilots, the hesitation to admit embarrassment is not surprising.

VARIABLE 42: DENIAL/LAINED

Figure C23

TYPE (DENIAL)	.	0	1	2	3	4	5	6	7	8	9	10	11
N	71	177	8	3	2	3	5	3	1	1	1	0	7

TYPE (LAINED)	0	1	2	3
N	177	18	6	7
%	85	9	3	3

Only 15 percent of the subjects experienced initial feelings of denial - i.e., "G-LOC did not occur-/ could not have occurred"

VARIABLE 43: ANGER/REGNA

Figure C23

TYPE (ANGER)	.	0	1	2	3	4	5	6	7	8	9	10	11
N	67	165	4	2	4	5	7	3	2	2	0	1	17

TYPE (REGNA)	0	1	2	3
N	165	22	8	17
%	78	10	4	8

Few subjects experienced anger. However, when it occurred, it was very obvious and usually related to feelings of failure and embarrassment.

VARIABLE 44: CONFUSED/DESUFNOC

Figure C23

TYPE (CONFUSED)		0	1	2	3	4	5	6	7	8	9	10	11
N	67	66	3	4	2	1	6	6	6	8	12	15	83

TYPE (desufnoc)	0	1	2	3
N	66	16	47	83
%	31	8	22	39

By far the most popular sensation reported by the subjects. Subjects were seldom hesitant in admitting their confusion. Some blamed this confusion partially to a dream i.e., the centrifuge surroundings (as they regained consciousness) were unexpected (not those of the dream).

VARIABLE 45: RELAX/XALER

Figure C23

TYPE (RELAX)		0	1	2	3	4	5	6	7	8	9	10	11
N	87	111	2	0	1	2	10	4	4	5	12	11	30

TYPE (xaler)	0	1	2	3
N	111	15	36	30
%	58	8	19	15

Many subjects found the G-LOC experience relaxing as if awakening from a nap.

VARIABLE 46: FRIGHT/THGIRF

Figure C23

TYPE (FRIGHT)		0	1	2	3	4	5	6	7	8	9	10	11
N	68	184	8	6	3	0	2	3	1	1	0	0	3

TYPE (THGIRF)	0	1	2	3
N	184	19	5	3
%	87	9	3	1

This variable is porbably underestimated given the typical pilot personality. Only 13% of the subjects admitted to having being frightened by the experience where the majority of the subject's gestures (videotape observation) probably demonstrated otherwise.

VARIABLE 47: APATHY/YHTAPA

Figure C24

TYPE (APATHY)		0	1	2	3	4	5	6	7	8	9	10	11
N	172	68	2	7	4	2	7	5	5	2	1	1	3

TYPE (YHTAPA)	0	1	2	3
N	68	22	14	3
%	64	21	13	2

Some subjects experienced apathy, a sense of "completion" associated with a "do not care" attitude which was often reflected when asked for the reasons the appropriate signals (HORNWHY (58)) were not deactivated (as instructed) when they regained consciousness.

VARIABLE 48: FRUSTRAT/TARTSURF

Figure C24

TYPE (FRUSTRAT)		0	1	2	3	4	5	6	7	8	9	10	11
N	68	135	2	1	0	3	9	6	2	8	3	10	26

TYPE (TARTSURF)	0	1	2	3
N	135	21	29	26
%	64	10	14	12

Frustration was usually more evident of those subjects experiencing G-LOC more than one time and was associated with anger.

VARIABLE 49: SADNESS/SSENDAS

Figure C24

TYPE (SADNESS)		0	1	2	3	4	5	6	7	8	9	10	11
N	68	188	9	4	2	1	2	1	0	0	0	2	2

TYPE (SSENDAS)	0	1	2	3
N	188	18	3	2
%	89	9	1	1

Few subjects experienced sadness other than that associated with failure in accomplishing a "successful" +Gz exposure.

VARIABLE 50 SORPRESA/ASERPROS

Figure C24

TYPE (SORPRESA)		0	1	2	3	4	5	6	7	8	9	10	11
N	118	77	3	2	1	5	10	7	11	7	5	7	26

TYPE (ASERPROS)	0	1	2	3
N	77	21	37	26
%	48	13	23	16

This variable is associated with variable (52). About 50 percent of the subjects did not recognize G-LOC was imminent.

VARIABLE 51: OTHER/REHTO

Figure 24

TYPE (OTHER)		0	1	2	3	4	5	6	7	8	9	10	11
N	72	202	0	0	0	0	0	0	0	0	0	0	5

TYPE (REHTO)	0	1	2	3
N	202	0	0	5
%	98	0	0	2

OTHER: floating sensation, loss of time, fatigue, disappointment, desire for gaining control, urgency.

VARIABLE 52: SURPRISE/ESIRPRUS

Figure C24
Frequency:

TYPE	N	%	%
.	67	24	-
F	121	43	57
T	91	33	43
T	279	100	100

VARIABLE 53: BLACKOUT

Figure C25
Frequency:

TYPE	N	%	%
.	140	50	-
F	54	19	39
T	85	31	61
T	279	100	100

VARIABLE 54: WHEREAMI

Figure C26
Frequency:

TYPE	N	%	%
.	70	25	-
F	77	28	37
T	132	47	63
T	279	100	100

A significant amount of subjects were initially confused as to their surroundings. Again, this confusion was usually associated with the occurrence of dreams/thoughts.

VARIABLE 55: GUESSUCS

Frequency:

TYPE	N	%	%
.	84	30	-
S	165	59	85
M	26	9	13
H	2	1	1
F	2	1	1
T	279	100	100

Most subjects estimated their period of unconsciousness correctly

VARIABLE 56: HORNUCS

Figure C27
Frequency:

TYPE	N	%	%
.	90	32	-
F	124	45	66
T	65	23	34
T	279	100	100

A significant amount of subjects reported having been aware of the warning sinals (horn) while unconscious. Usually, they associated the signal with the auditory stimuli of their dream (if any).

VARIABLE 57: HORNOFF

Figure C28
Frequency:

TYPE	N	%	%
.	81	29	-
F	116	42	59
T	82	29	41
T	279	100	100

Subjects usually acknowledged not having promptly deactivated the warning sinals upon regaining consciousness as instructed.

VARIABLE 58: HORNWHY

Figure C29
Frequency:

TYPE	.	A	B	C	D	E	F	G	H	I
N	167	9	14	4	10	43	5	12	4	11
%	60	3	5	1	4	16	2	4	1	4
%	-	8	13	4	9	38	5	11	4	10

H = OTHER: head tumbling; signals are part of dream (alarm clock); error (activated while convulsing)
The most typical reason for not deactivating the warning signals was confusion.

VARIABLE 59: SLEEPARY

Figure C30
Frequency:

TYPE	N	%	%
.	43	15	-
F	165	59	70
T	71	26	30
T	279	100	100

Unfortunately, those subjects who reported having experienced sleep paralysis-like symptoms during normal sleep were not asked if these symptoms were comparable to the transient lack of muscle control (subject not being able to move to deactivate the warning signals, HORNWHY="b") if any.

VARIABLE 60: FLAILING

Figure C31
Frequency:

TYPE	N	%	%
.	36	13	-
F	30	11	12
T	213	76	88
T	279	100	100

VARIABLE 61: ERELOC

Figures C32 - C33
Frequency:

TYPE	N	%	%
.	31	12	-
F	159	56	64
T	89	32	36
T	279	100	100

TABLE 9. Incapacitation Variables Associated with the Occurrence of Prior G-LOC Experience.

	ERELOC						
VARIABLE	F			T			
	mean	s.d	n	mean	s.d.	n	p
CONINDTI	3.4	2.5	88	3.1	2.4	67	
CONVTIM	4.7	2.6	83	4.3	2.1	62	
ABSOLUTE	7.6	5.9	98	6.3	3.0	59	
RELATIVE	9.2	4.8	94	8.0	3.4	58	
TOTAL	15.2	6.3	117	13.2	5.2	70	.020
PIGTIME	3.6	2.2	30	3.1	1.9	20	
TOYINCAP	15.0	8.0	120	12.4	5.0	71	.006
TOYINCER	1.6	0.8	48	1.6	0.6	31	
CNVTMAWK	3.0	2.3	53	2.7	1.5	43	
ERELOCN			0			1 to 6	

There seemsto be an association: G-LOC prior experience and a reduced total incapaciation time.

VARIABLE 62: ERELOCN

GTIP exposures: (85) [1 to 6]

VARIABLE 63: ERELOCWH

Figure C34
Frequency:

TYPE	N	%	%
.	191	68	-
FUGE	69	25	78
FLITE	14	5	16
BOTH	5	2	6
T	279	100	100

VARIABLE 64: EVENTQUA

Figure C35
Frequency:

TYPE	N	%	%
.	195	70	-
FAM	62	22	74
UFAM	22	8	26
T	279	200	100

VARIABLE 65: EVENTACT

Figure C36
Frequency:

TYPE	N	%	%
.	204	73	-
ACT	41	15	54
PAS	34	12	46
T	279	100	100

VARIABLE 66: EVENTINT

Figure C37
Frequency:

TYPE	N	%	%
.	196	70	-
VIV	31	11	37
HAZ	52	19	63
T	279	100	100

VARIABLE 67: EVENTELM

Figure C38
Frequency:

TYPE	N	%	%
.	216	77	-
AUD	5	2	8
VIS	36	13	57
NONE	3	1	5
BOTH	19	7	30
T	279	100	100

VARIABLE 68: SLIPDREM

Figure C39
Frequency:

TYPE	N	%	%
.	224	80	-
F	20	7	41
T	35	13	59
T	279	100	100

About half of the subjects that experienced dreams while unconscious considered them *rable to those experienced during normal sleep (see variable [81]).*

VARIABLE 69: DREMRCAL

Figure C40
Frequency:

TYPE	N	%	%
.	56	20	-
F	91	33	41
T	132	47	59
T	279	100	100

VARIABLE 70: AGE {yrs}

GTIP exposures: 31.4 ± 7.2 (273) [20 to 61]

VARIABLE 71: WEIGHT {lbs}

GTIP exposures: 177.4 ± 18.8 (260) [117-225]

VARIABLE 72: HEIGHT {in}

GTIP exposures: 71.5 ± 2.6 (259) [58 to 77]

VARIABLE 73: JOB

Figure C41
Frequency:

TYPE	N	%	%
.	18	6	-
AIR	73	26	28
NAVY	185	67	71
OTHER	3	1	1
T	279	100	100

TABLE 10. Subject Characteristics as Related to Their Military Affiliation. (mean ± S.D. (N))

	JOB		
VARIABLE	**AIR**	**NAVY**	**p**
RELTOL	4.6 ± 0.8 (68)	4.6 ± 0.8 (185)	
AGE	38.9 ± 7.6 (71)	28.6 ± 4.3 (182)	.000
WEIGHT	178.5 ± 21.3 (68)	177.0 ± 17.9 (181)	
HEIGHT	71.5 ± 2.4 (68)	71.5 ± 2.7 (180)	
AEROBIC	2.9 ± 2.1 (51)	3.4 ± 2.0 (138)	
ANAEROBI	3.2 ± 1.7 (30)	3.5 ± 2.4 (98)	

VARIABLE 74: PPBPBG

Frequency:

TYPE	N	%
.	0	0
F	279	100
T	0	0
T	279	100

VARIABLE 75: EVQUAL

Figure C42
Frequency:

TYPE	N	%	%
.	193	69	-
P	56	20	65
U	16	6	19
I	14	5	16
T	279	100	100

VARIABLE 76: GENDER

Frequency:

TYPE	N	%
F	2	1
M	277	99
T	279	100

VARIABLE 77: AEROBIC/CIBOREA {hrs/wk}

Figure C43
G exposures (AEROBIC): 2.5 ± 2.2 (251) [0 to 10]

Frequency:

TYPE	N	%	% (CIBOREA)
.	28	10	-
0	56	20	22
1	195	70	78
T	279	100	100

VARIABLE 78: ANAEROBI/IBOREANA (hrs/wk)

Figure C44
G exposures (ANAEROBI): 1.7 ± 2.3 (250) [0 to 14]

Frequency:

TYPE	N	%	% (IBOREANA)
.	29	10	-
0	121	43	48
1	129	47	52
T	279	100	100

VARIABLE 79: WORK

Figure C45
Frequency:

TYPE	N	%	%
.	20	7	-
FO	200	72	77
NFO	59	21	23
T	279	100	100

VARIABLE 80: AIRCRAFT

Figure C46
Frequency:

TYPE	N	%	%
.	30	11	-
A10	24	9	10
A37	6	2	2
A4	4	1	2
A6	32	12	13
A7	19	7	8
AV8	9	3	4
F14	56	20	23
F15	4	1	2
F16	17	6	7
F18	49	18	20
F4	17	6	7
F5	1	.4	
FA2	1	.4	
H53	2	2	
T2	1	.4	
T34	5	2	2
T37	1	.4	
T4	1	.4	
T	279	100	100

VARIABLE 81: DRMWHR

Figure C47
Frequency:

TYPE	N	%	%
.	234	84	-
B	5	2	11
M	26	9	58
E	14	5	31
T	279	100	100

In summary, illusions were 1) of a familiar setting, 2) related to recent events in the subject's experience, 3) difficult to recall if not asked to relate their content immediately upon regaining consciousness. Dream content was seldom auditory in nature, and if so, the auditory elements were associated with the warning signals. Finally, the subjects estimated their dream having occurred during the middle portion of their incapacitation period.

VARIABLE 82: FLALAWAR

Figure C48
Frequency:

TYPE	N	%	%
.	111	40	-
F	115	41	68
T	53	19	32
T	279	100	100

Most subjects were not aware of having flailed during their unconsciousness period.

VARIABLE 83: CENTRIFU

Frequency:

TYPE	N	%
SAM	14	5
NADC	265	95
T	279	100

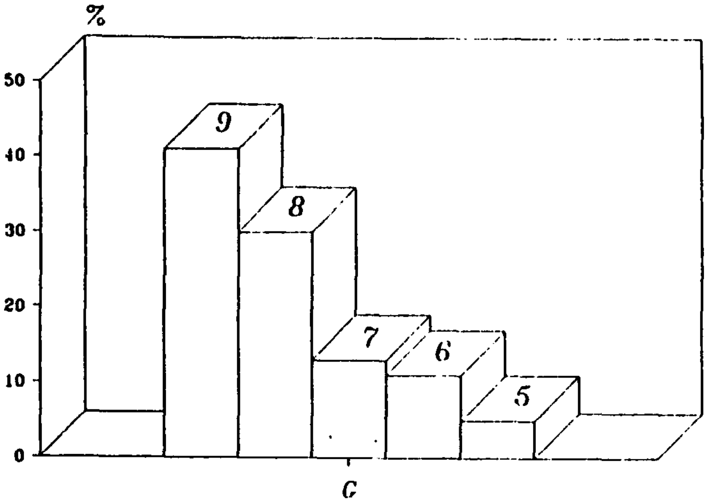


Figure C1. Maximum G level (GXAM)

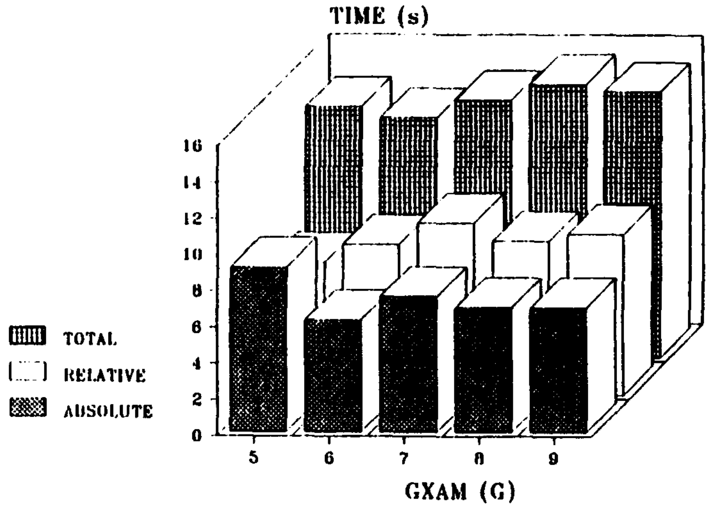


Figure C2. Maximum G: Incapacitation

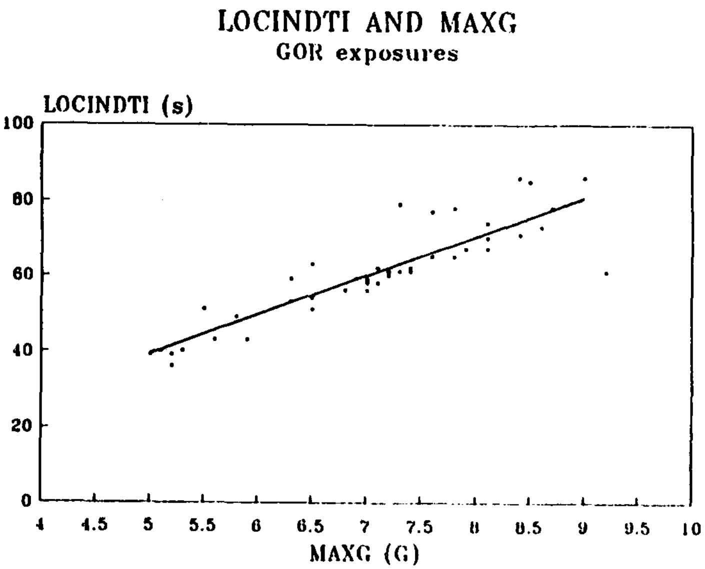


Figure C3.

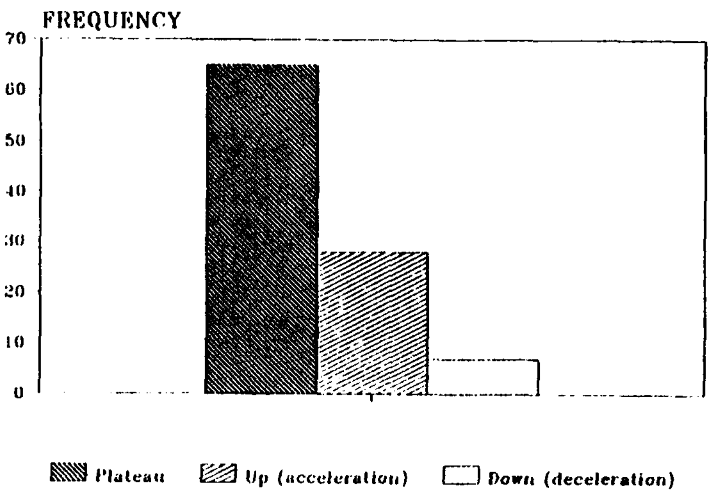


Figure C4. WHENLOC

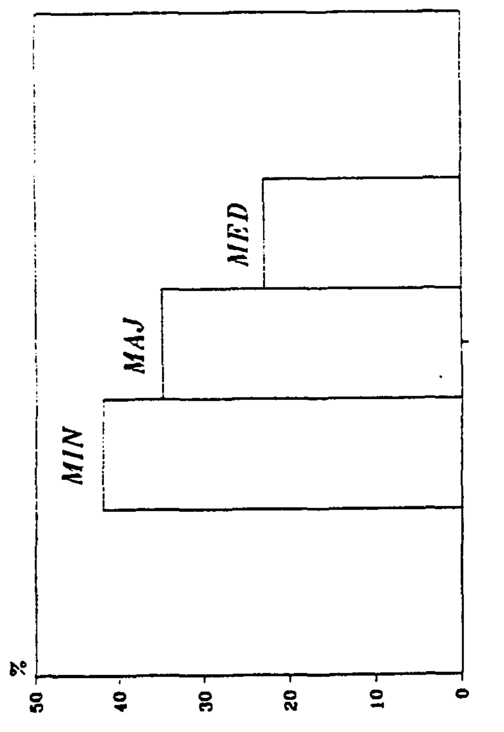


Figure C5. Convulsion type (CONVTYP)

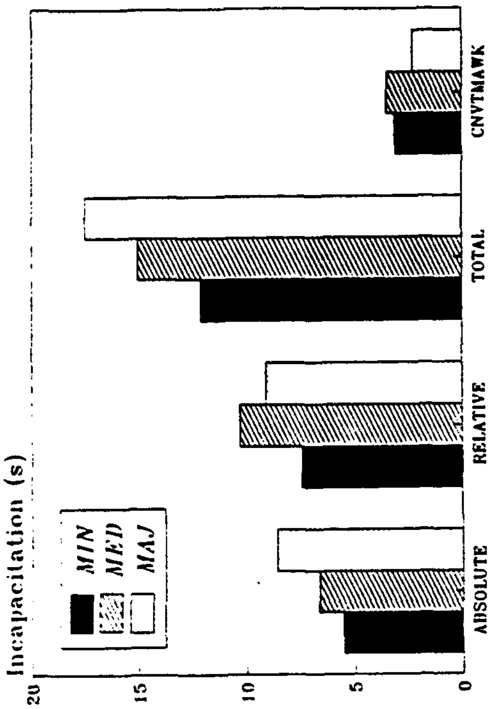


Figure C6. CONVTYP and incapacitation

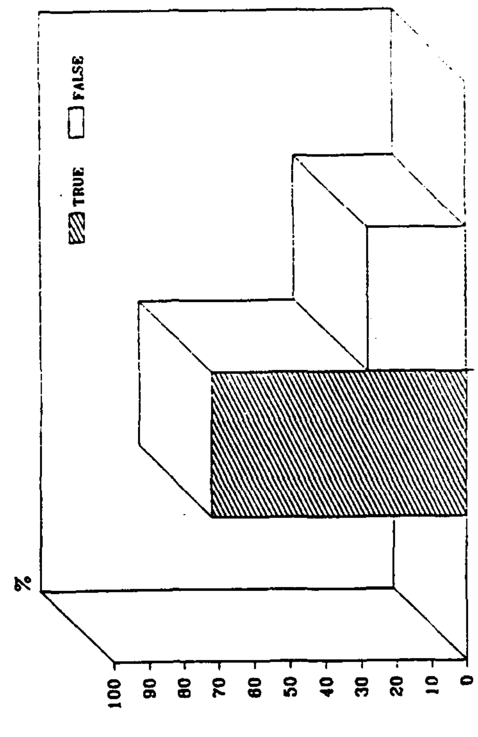


Figure C7. G-suit activation

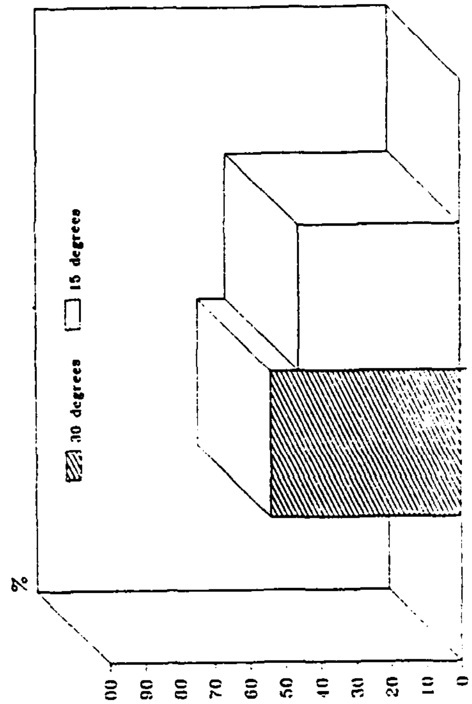


Figure C8. Seat angle (STAT)

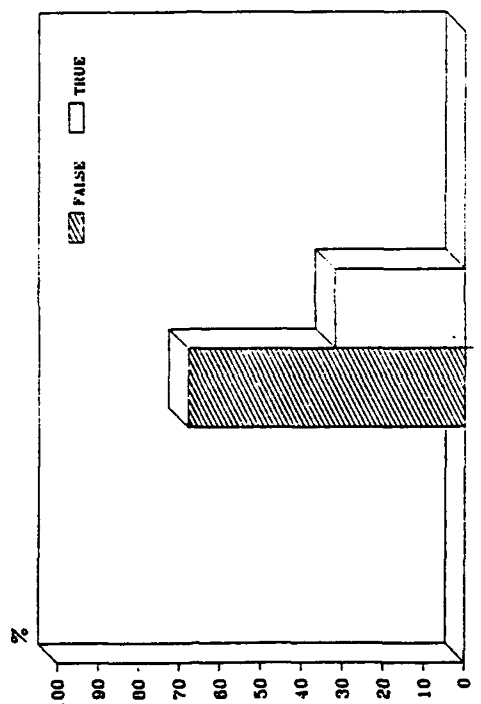


Figure C9. Breathing symptoms (BREATHE)

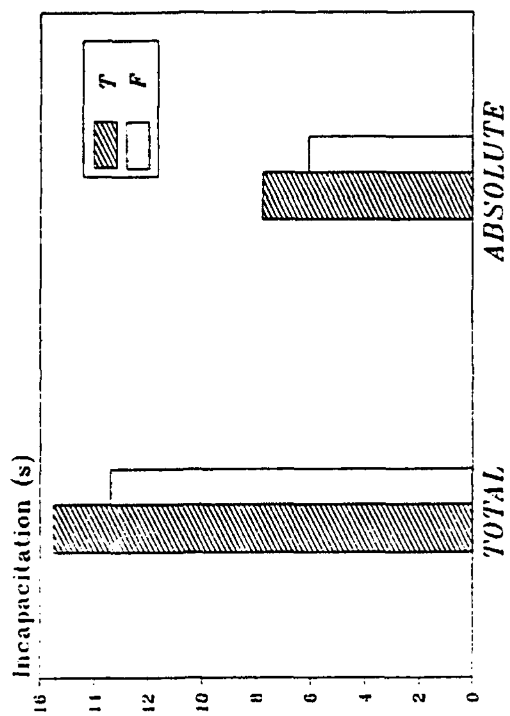


Figure C10. BREATHE incapacitation

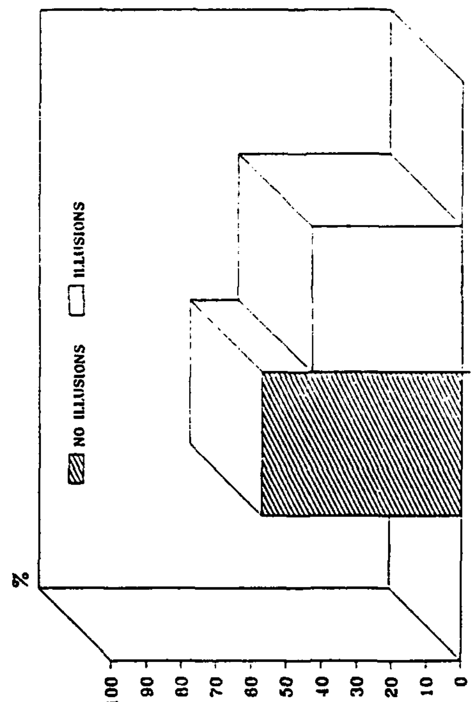


Figure C11. Event classified (EVENTO)

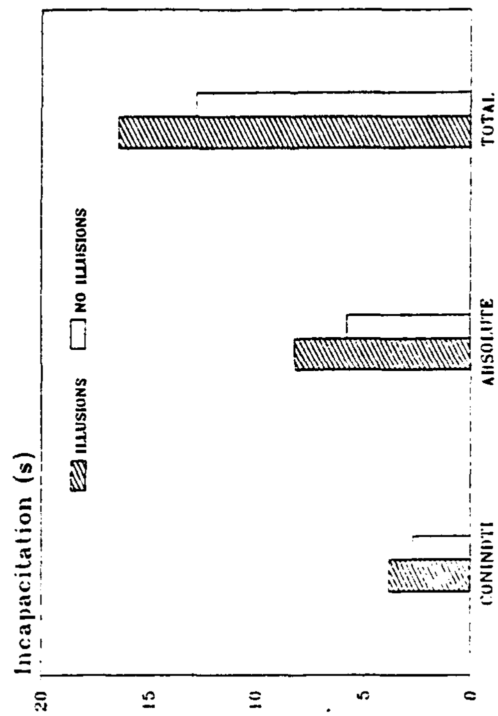


Figure C12. Incapacitation times (EVENTO)

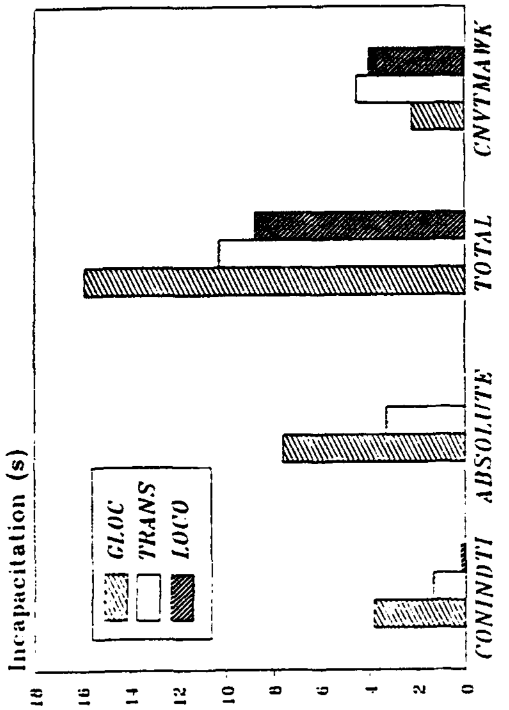


Figure C14. Incapacitation time (LOCTYP)

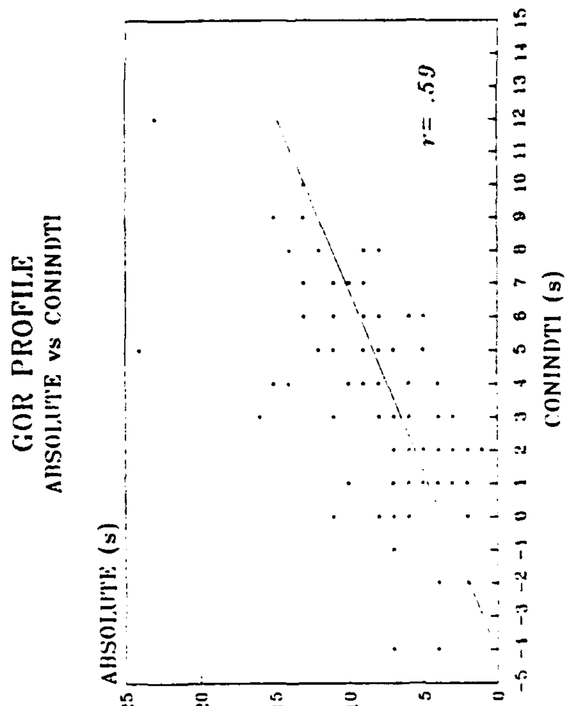


Figure C18

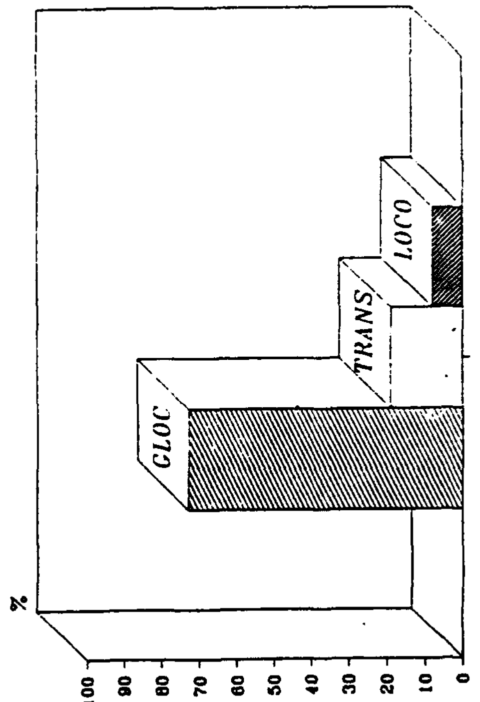


Figure C13. Unconsciousness type: LOCTYP

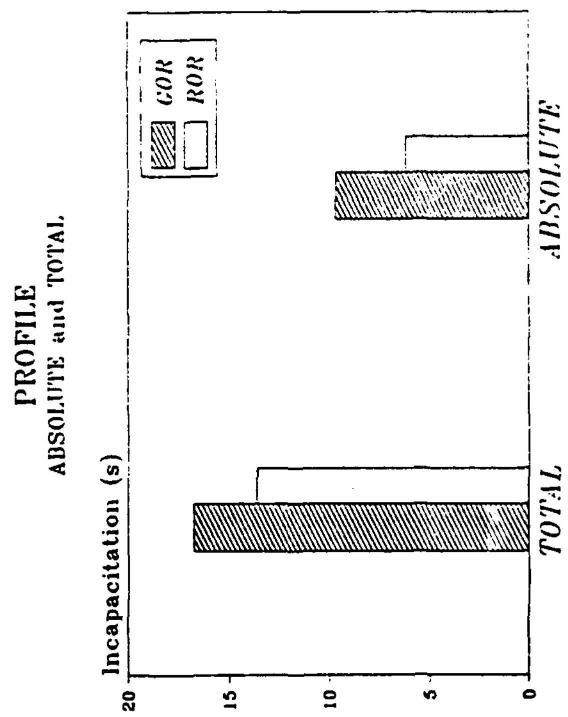


Figure C16.

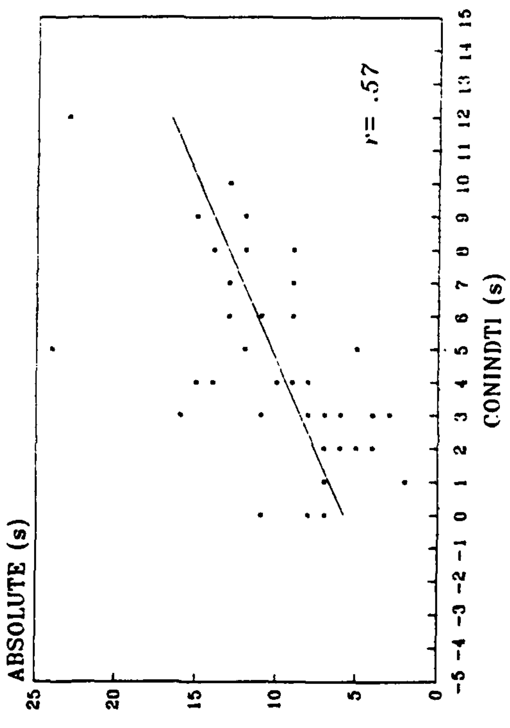


Figure C17. Rapid onset profile (ROR)

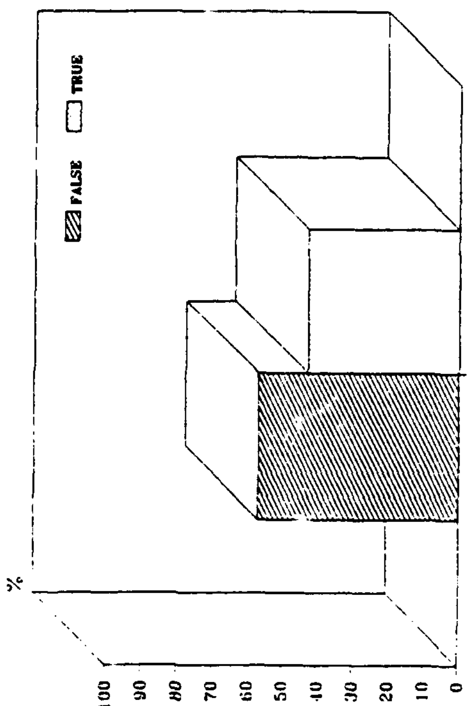


Figure C18. JOESUIT (upon GLOC)

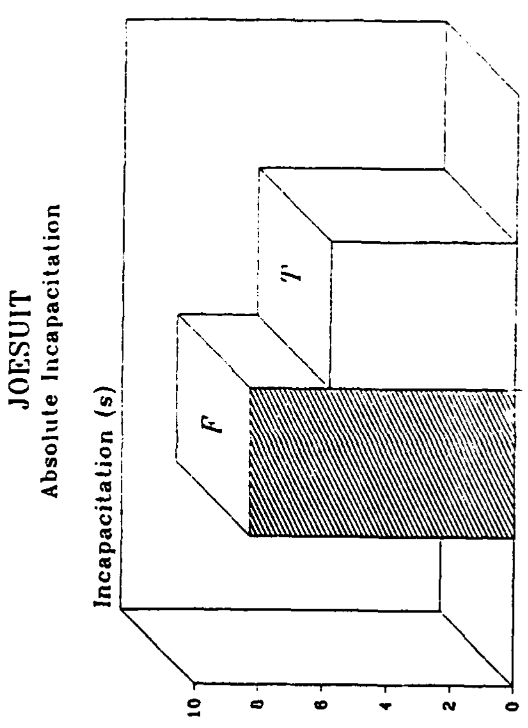


Figure C19. Incapacitation time

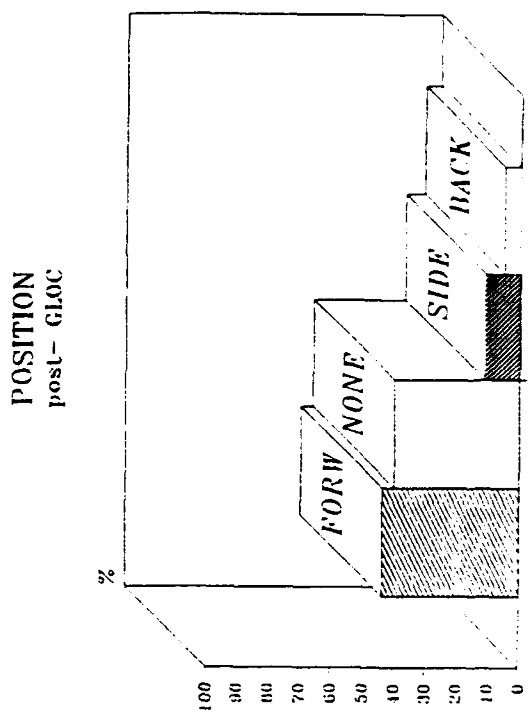


Figure C20

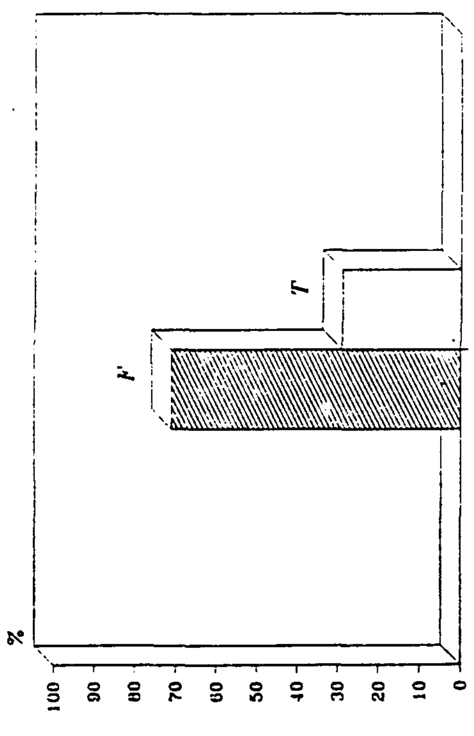


Figure C21. AMNESIA (True or False)

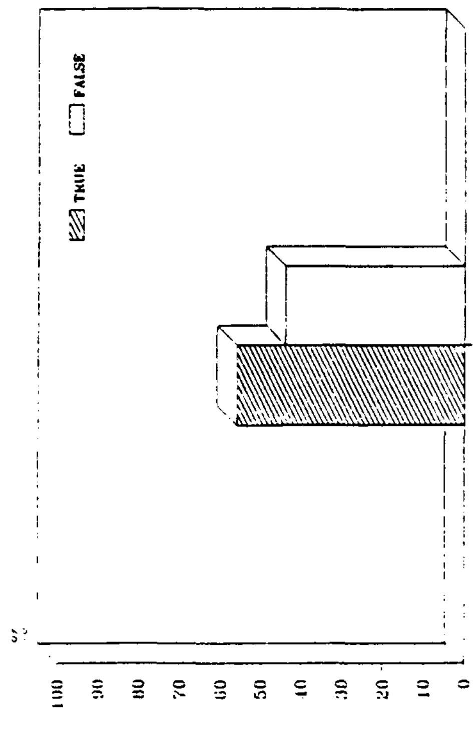


Figure C22. Motion sickness (MOTSICK)

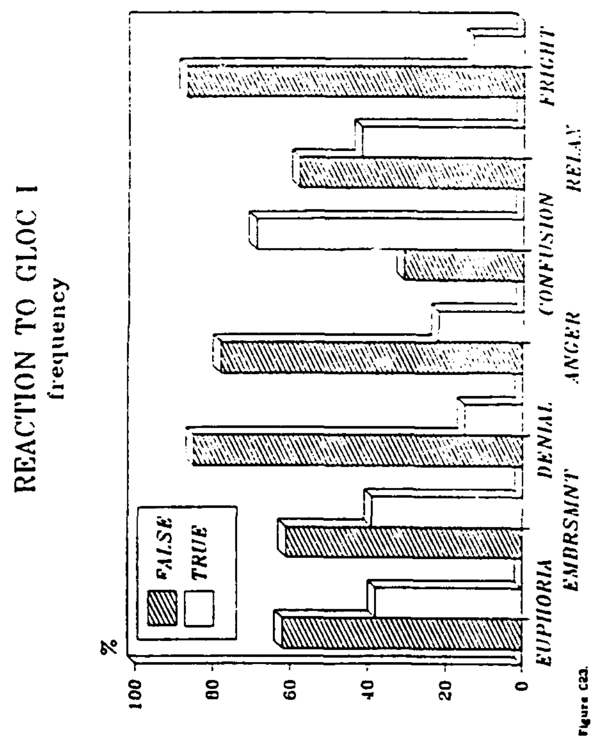


Figure C23.

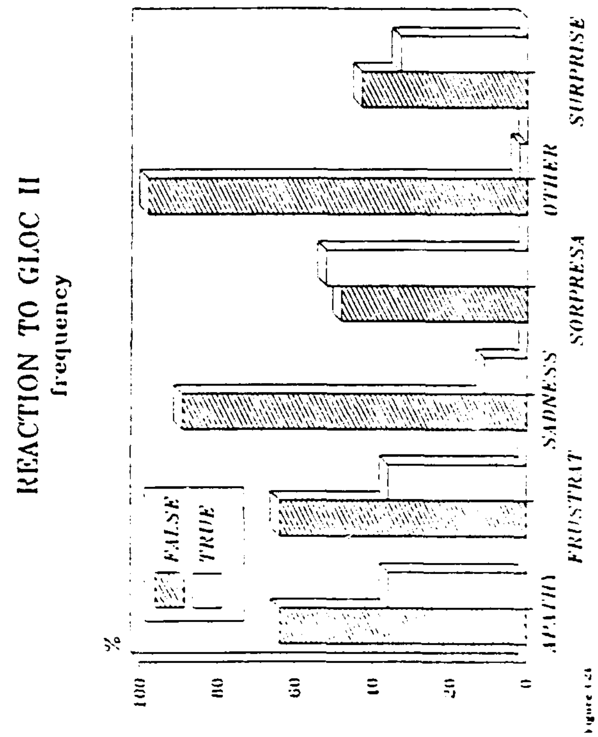


Figure C24

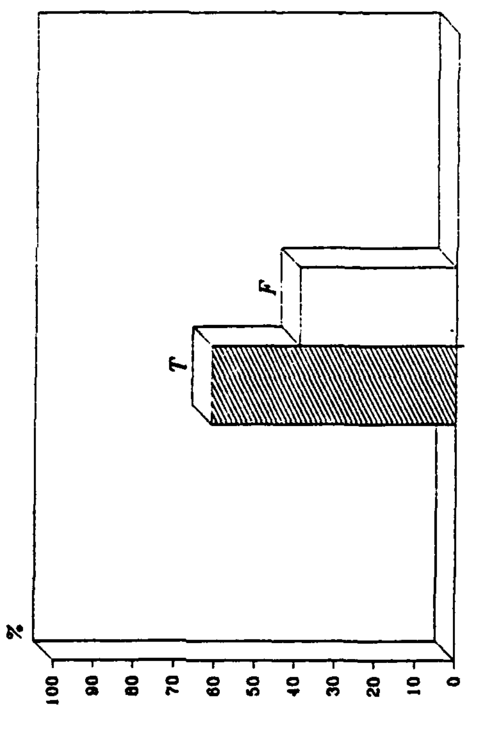


Figure C25. BLACKOUT (True or False)

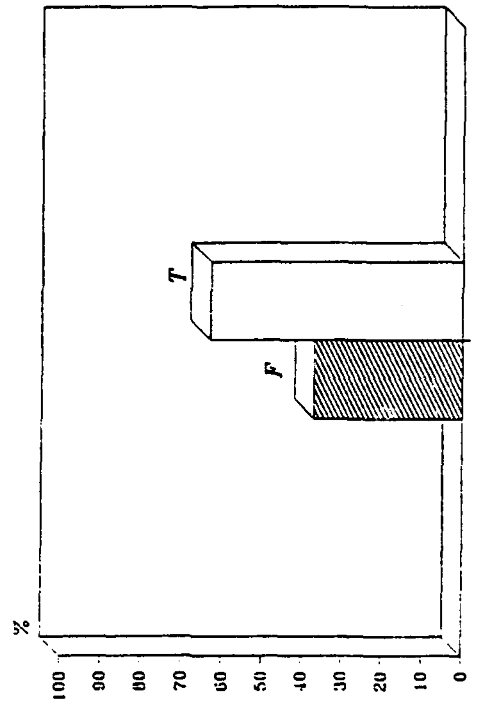


Figure C26. Awareness (WHEREAMI)

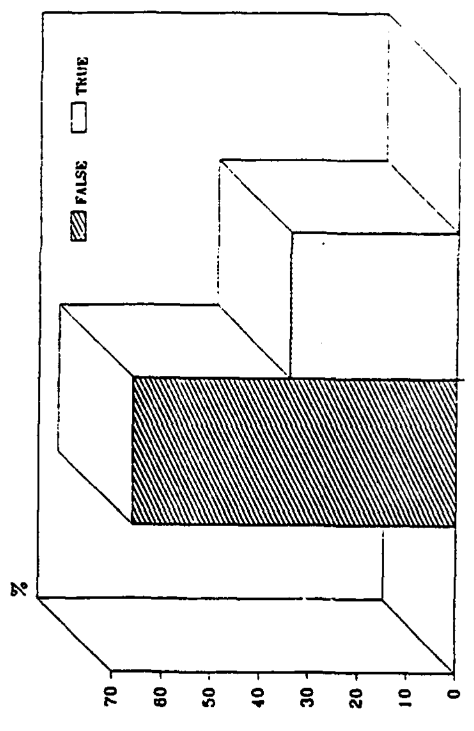


Figure C27. Aware of horn (HORNUCS)

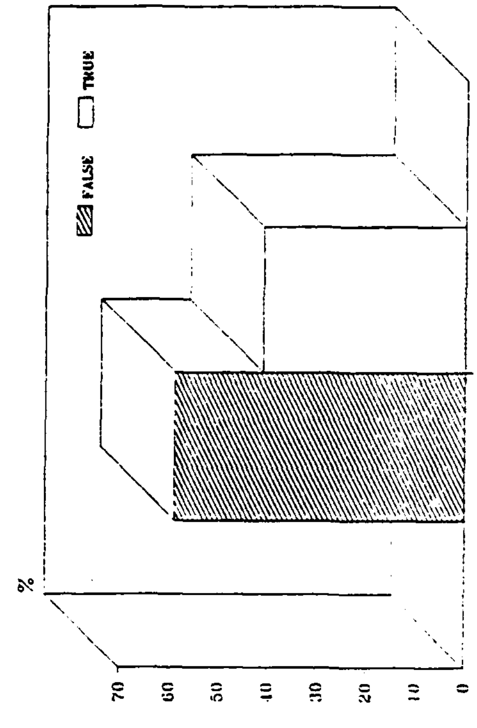


Figure C28 HORNOFF

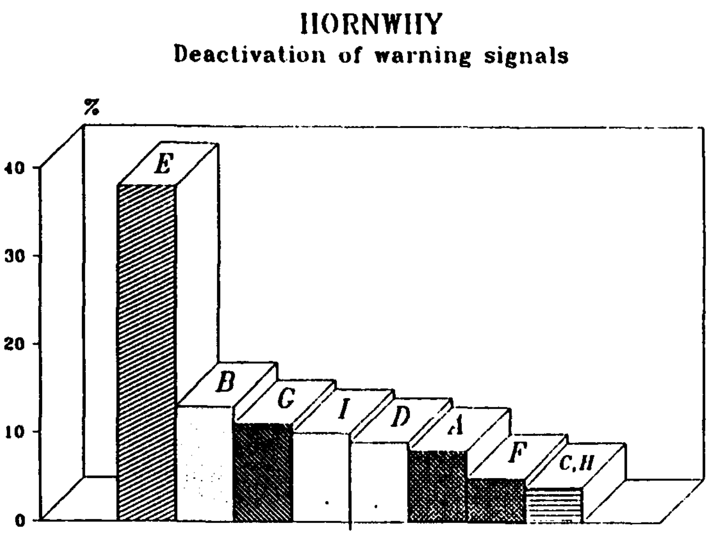


Figure C29. See text for definition

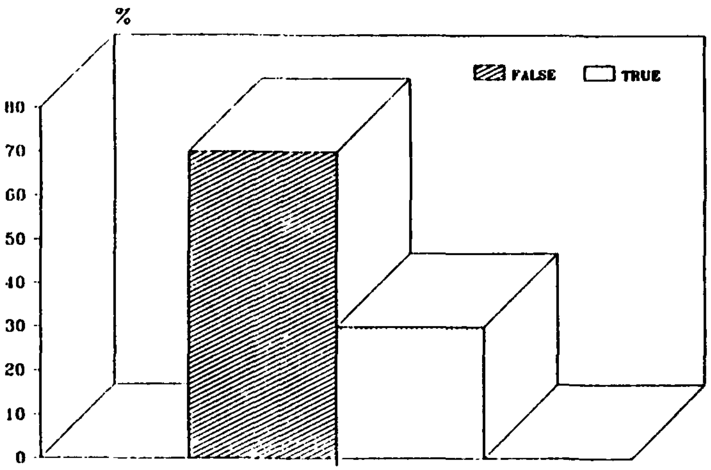


Figure C30. Sleep paralysis (SLEEPARY)

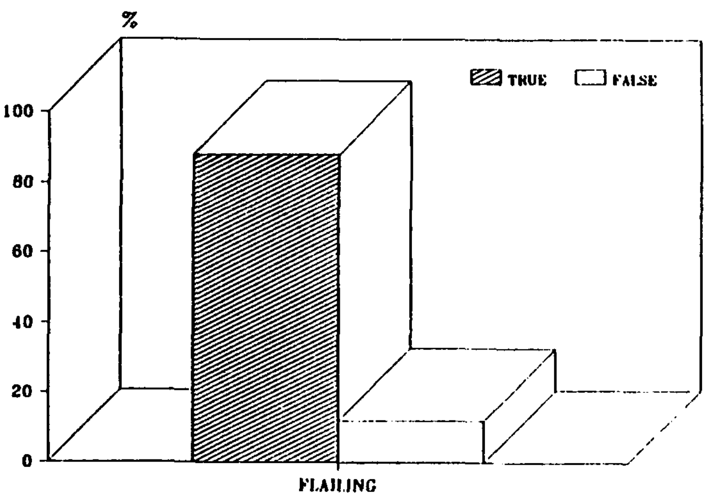


Figure C31. FLAILING

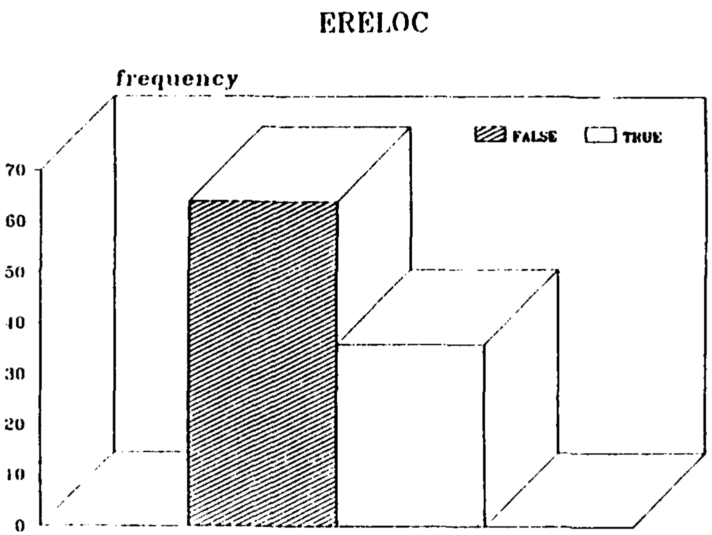


Figure C32. Prior GLOC experience

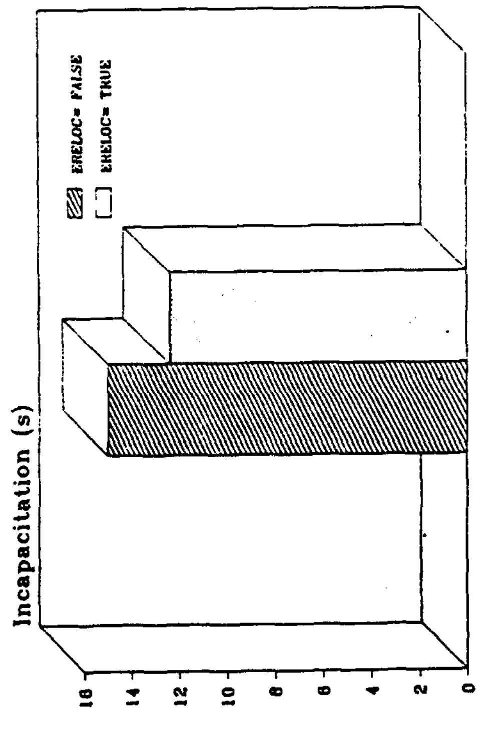


Figure C33. TOTAL Incapacitation: ERELOC

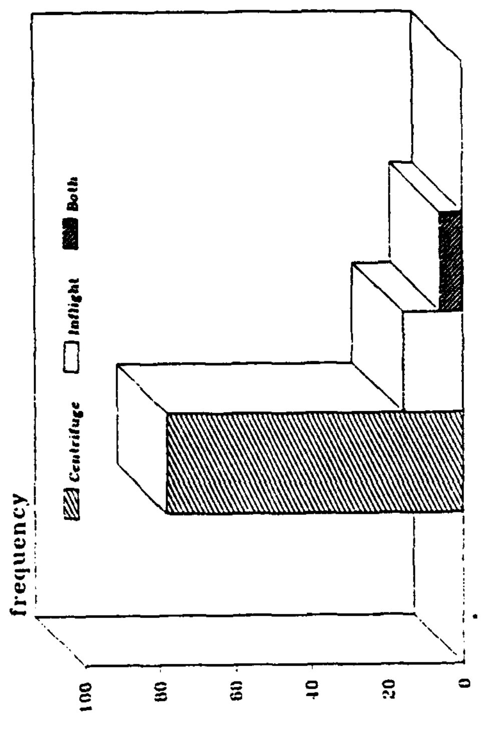


Figure C34. ERELOC where (ERELOCWH)

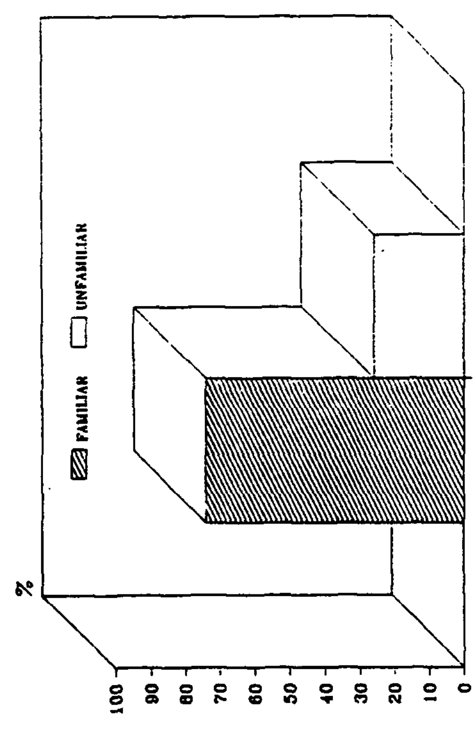


Figure C35. Event quality (EVENTQUA)

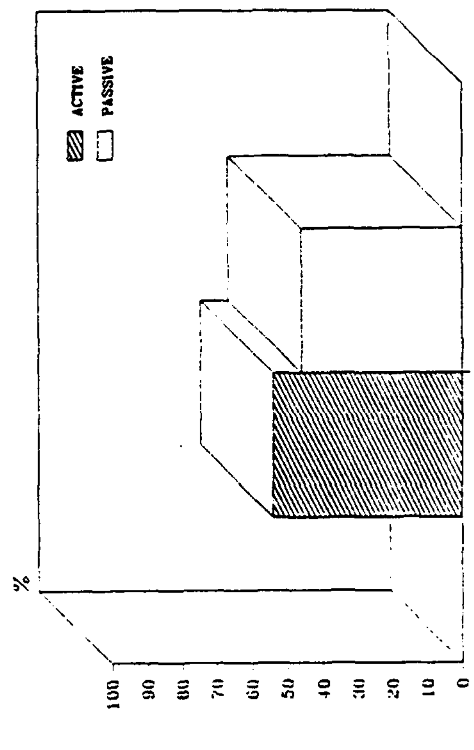


Figure C36. Event activity (EVENTACT)

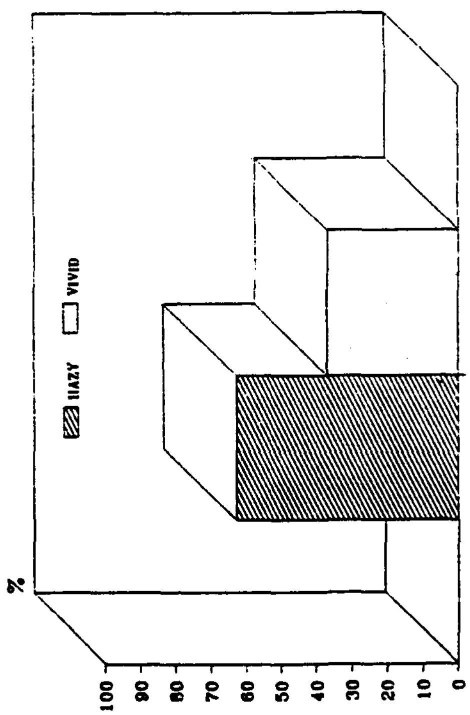


Figure C37. Event intensity (EVENTINT)

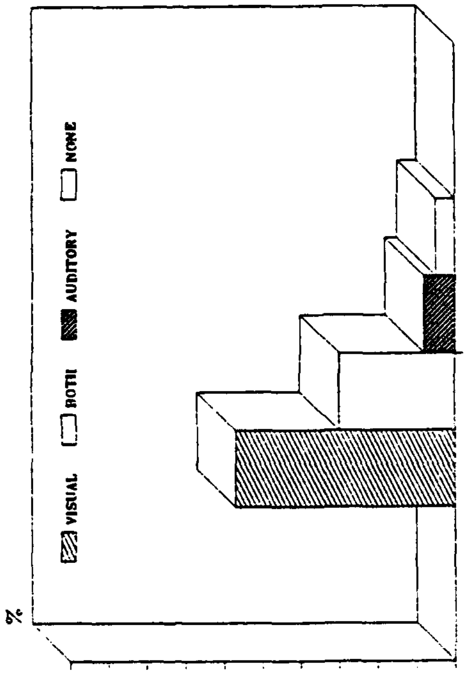


Figure C38. Event elements (EVENTELM)

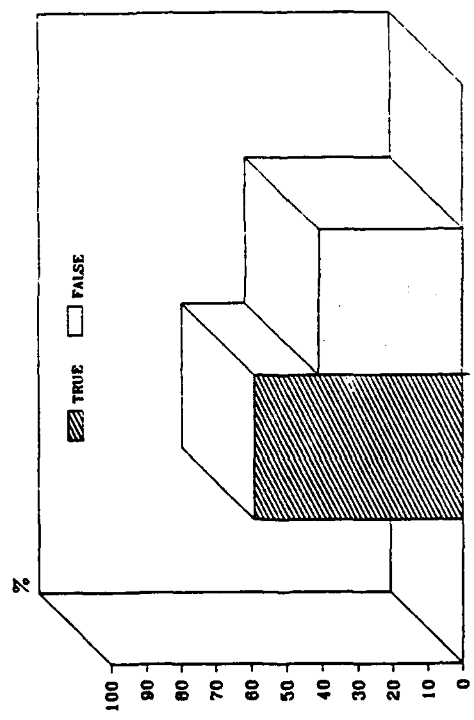


Figure C39. Sleep=Dream? (SLPDREM)

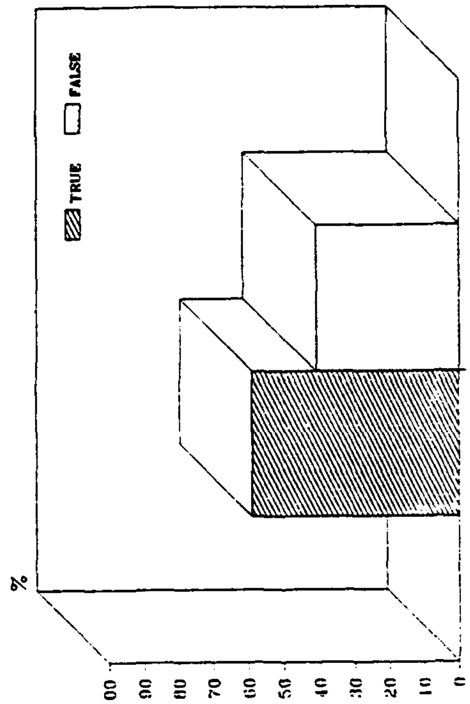


Figure C40. Dream recall (DREMRCAL)

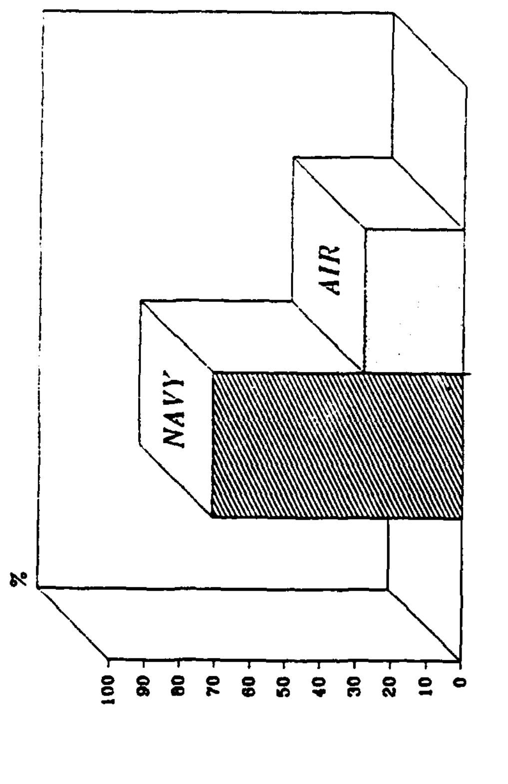


Figure C41. Type of job (JOB)

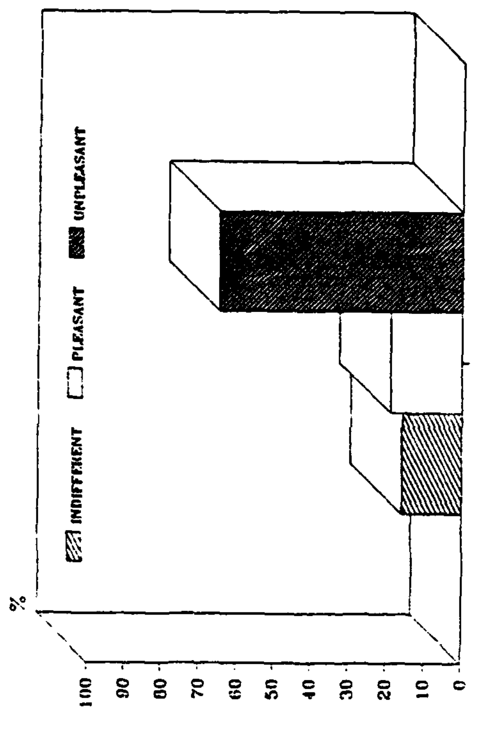


Figure C42. Event quality (EVQUAL)

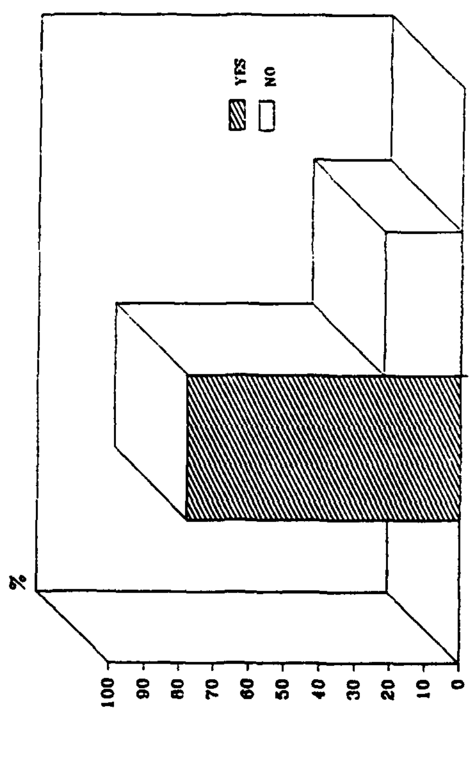


Figure C43. Aerobic training: CIBOREA

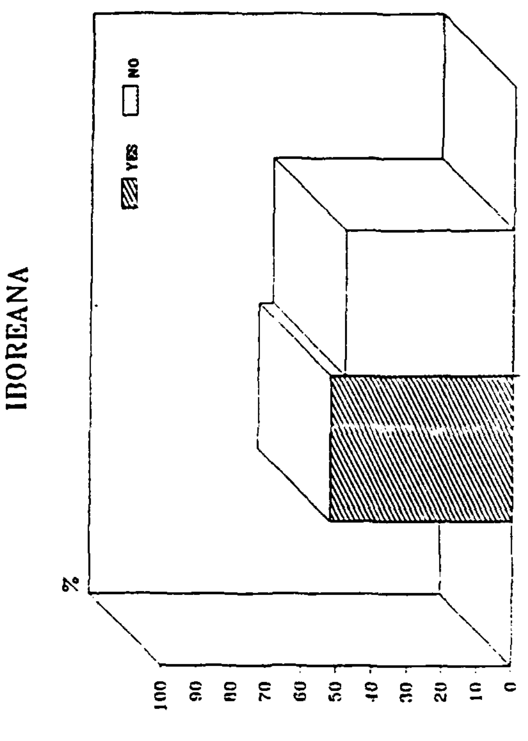


Figure C44. Anaerobic exercise

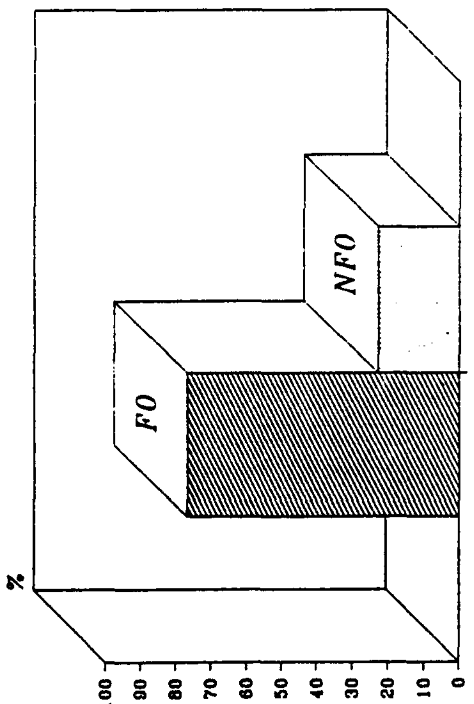


Figure C45. Flying duties (WORK)

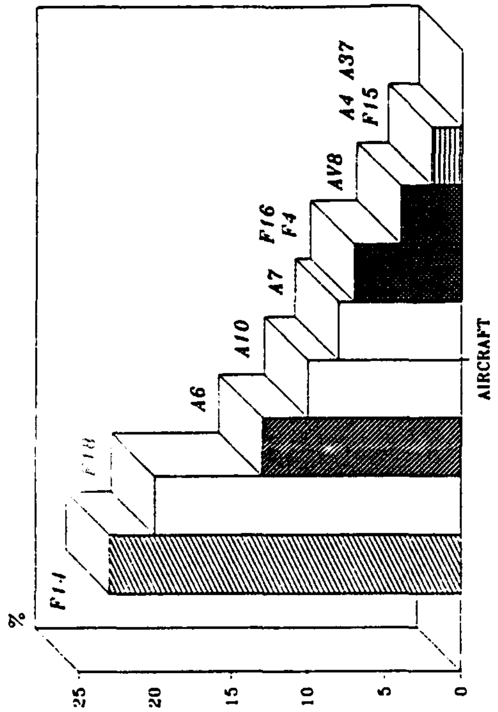


Figure C46. Type of AIRCRAFT

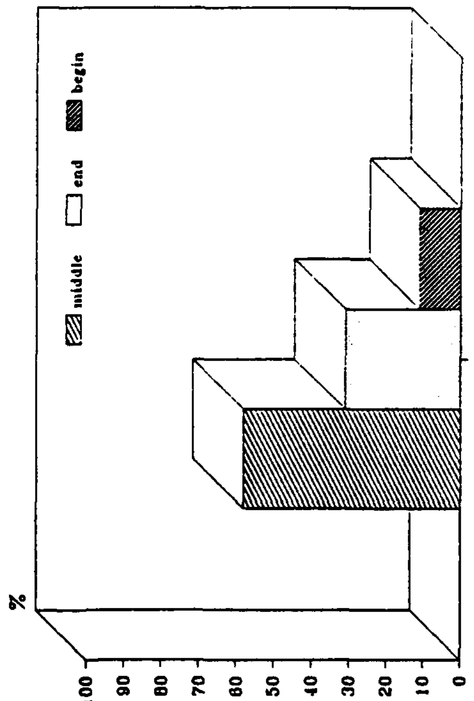


Figure C47. [illegible]

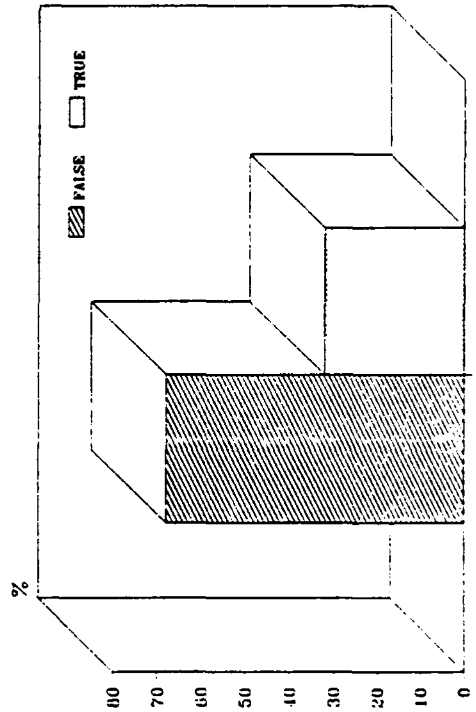


Figure C48. Aware of [illegible]

Distribution List (Continued)
Report No. NAWCADWAR 92026-50

	No. of Copies
Air Force Office of Scientific Research Bolling AFB, DC 20332-6448	1
Naval Aerospace Medical Institute Naval Air Station, Pensacola, FL 32508	2
FAA Civil Aeromedical Institute Oklahoma City, OK 73124	1
NASA Ames Research Center Moffott Field, CA 94035	1
NASA Johnson Space Center Houston, TX 77058	1
Dr. Don Jarson Drexel University Philadelphia, PA 19104	1
Commandant of the Marines Headquarters Marine Corps Washington, DC 20380	1
Naval Weapons Center China Lake, CA 93555-6001	1
Naval Air Force U.S. Pacific Fleet NAS North Island San Diego, CA 92135	1
Commander, Naval Air Force. U.S. Atlantic Fleet Norfolk, VA 23511-5188	1
Center for Naval Analyses 4401 Fort Ave., P.O. Box 16268 Alexandria, VA 22302-0268	1
U.S. Air Forces In Europe (USAFE) Office of the Command Surgeon/SG APO, New York 09094-5001	1
Mr. Robert Montgomery 125 James Way ETC Corporation Southampton, PA 18966-3877	1
Dr Jean-Michel Clere Lamas/CEV F-91228 Bretigny-SUR-ORGE CEDEX FRANCE	1

Distribution List (Continued)
Report No. NAWCADWAR 92026-50

	No. of Copies
Dr. David Glaister, Royal Air Force Institute of Aviation Medicine Farnborough Hants GU14652 England	1
Mr. Michael Paul, Defense and Civil Institute of Environmental Medicine 1133 Sheppard Avenue P.O. Box 2000 Downsview, Ontario, Canada	1
Air University Library AUL/LSE, Maxwell AFB, AL 36112	1
Armstrong Laboratory Strughold Aeromedical Library/TSK-4 Brooks AFB, TX 78235	1
Commander, USAF Armstrong Aerospace Medical Research Lab Wright-Patterson AFB, OH 45433	1
Commander, Naval Training Systems Command 12350 Research Parkway Orlando, FL 32826	1
U.S. Air Force Tactical Air Command Office of the Command Surgeon (SGP) Langley AFB, VA 23665	1
Naval Air Warfare Center Warminster, PA 18974-0591 (1 Copy for Office of Chief Aeromedical Scientist) (2 Copies for Code 0471)	3
Commander, Naval Air Systems Command Washington, DC 20361 (3 Copies for AIR-320R) (2 Copies for AIR-931H) (1 Copy for AIR-531B) (2 Copies for AIR-5004)	8
1299th Physiological Training Flight Malcolm Grow USAF Medical Center Andrews AFB, Washington, DC 20331-5300	1
Dr. Fred Buick DCIEM 1133 Sheppard Ave W. North York, Ontario Canada M3M 3B9	1

Distribution List
Report No. NAWCADWAR 92026-50

No. of Copies

Defense Technical Information Center 2
Bldg. 5, Cameron Station, Alexandria, VA 22314

Chief of Naval Operations 4
Dept of the Navy, Washington, DC 20350
(1 Copy for NOP-506N)
(1 Copy for NOP-591)
(1 Copy for NOP-05H)
(1 Copy for NOP-09E)

Naval Aerospace Medicine Institute 2
Naval Air Station, Pensacola, FL 32508

Office of Naval Research 1
Code 1433, Washington, DC 20375
(1 Copy for Code 1433)

Naval Postgraduate School 1
Monterey, CA 93940

AL/CA-CF 1
Brooks AFB, TX 78235
(1 Copy for Dr. Russell R. Burton)

AL/CFTF 1
Brooks AFB, TX 78235
(1 Copy for Dr. John W. Burns)

Air National Guard Support Center 1
Mail Stop #18, Andrews AFB, DC 20331
(1 Copy for ANGSC/SG)

Advanced Physiologic Training Unit 1
833 Med Gp/SGT
Holloman AFB, NM 88330
(1 copy for 833 Med Gp/SGT)

Federal Aviation Administration 1
CAMI Library AAC 64D1, P.O. Box 25082
Oklahoma City, OK 73125
(1 Copy for Civil Aeromedical Institute)

Headquarters, U.S. Air Force 1
Bolling AFB, DC 20332
(1 Copy for Office of the Surgeon General (SGP))

Dr. Bill Albery 1
AL/CFEG Bldg 29
2245 Third St.
WPAFB OH 45433-7008